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IRRIGATION — IN — MONTANA



The Board of Railroad Commissioners
EX-OFFICIO
Montana Irrigation Commission
DECEMBER, 1920
HELENA, MONTANA



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IRRIGATION IN MONTANA



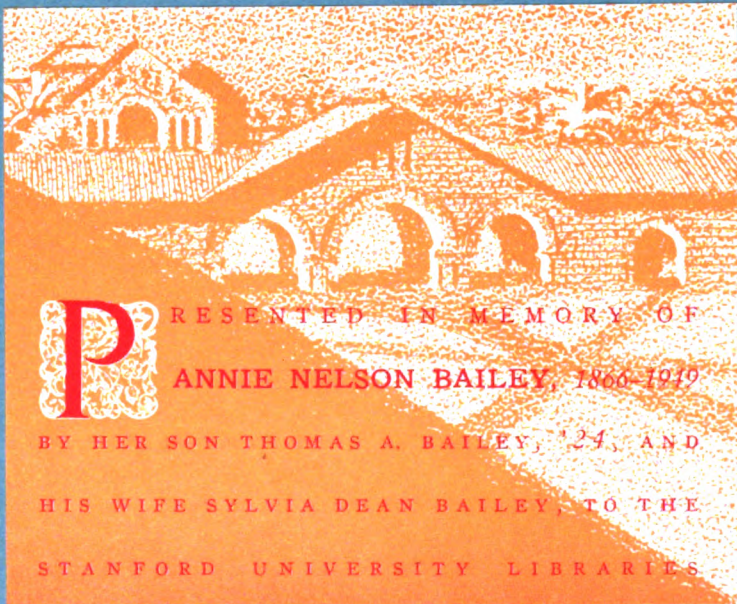
The Board of Railroad Commissioners

EX-OFFICIO

Montana Irrigation Commission

DECEMBER, 1920

HELENA, MONTANA



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ANNUAL REPORT
ON
Irrigation Possibilities
IN
MONTANA
BY THE
Montana Irrigation Commission

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HELENA, MONTANA, DECEMBER, 1920

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Address All Communications to Montana Irrigation Commission

FOREWORD

In presenting this report on the present development and future possibilities of irrigation in Montana, we ask the reader to bear in mind the financial conditions which have handicapped the Commission and the limited time in which to cover such a vast area. Personal visits were made to every county where interviews were arranged with officials and irrigators. The active co-operation and interest shown in every locality were very gratifying indeed and the Commission takes this opportunity of expressing its thanks and appreciation to all those who have so generously offered their time and assistance.

A great deal of data was gathered on projects which have not been included under the write-up of the counties on account of the excessive volume it would make. Many unusual and interesting data were gathered on pumping schemes, artesian water, hot springs, seepage, and so forth which could not be included. All such detailed information, however, is filed in the office for future reference.

The arrangement of the context of the report takes up, first, general information dealing with the origin and organization of the Montana Irrigation Commission, the needs of a state irrigation survey, the feasibility of pumping projects, reservoirs and irrigation statistics, including a summary of the findings and the ultimate irrigation possibilities of the state. This is followed by a complete description of the fifteen irrigation projects which have elected to come under the jurisdiction of the Commission, and also a brief outline of the projects contemplating forming districts under the Commission. The balance of the contents takes up in order a descriptive summary of all the Carey Act Projects in the state, the United States Reclamation and Indian Service Projects and then a short write-up of each county separately. In order to save space, the descriptive matter of the counties has been made as brief as possible and still sufficient detail has been entered into so as to include the predominating irrigation features.

MONTANA IRRIGATION COMMISSION

The Montana Railroad Commission was, by an act passed by the legislature assembled in extraordinary session in August, 1919, designated ex-officio the Montana Irrigation Commission. The law provides that the Commission shall have general supervisory control over the organization of irrigation districts in the state of Montana and "do all things necessary for the full development of the irrigable lands."

ORGANIZATION.

The act as originally passed carried an appropriation of \$10,000, but through a clerical error the appropriation was reduced to \$2,500. This has been a serious handicap in carrying out the provisions of the bill. A deficiency claim of \$7,500 was authorized pending the action of the coming legislature and all claims for salaries and expenses have been met by deficiency claims since the depletion of the available \$2,500.

The past year has seen a great deal of activity in irrigation questions. The demand made upon the Commission in the nature of investigating and reporting upon the feasibility and costs of districts and making preliminary visits to projects in the process of forming districts made it necessary to employ two additional engineers.

The original irrigation district law was passed by the legislature in 1907 and was similar in nature to the law relating to municipal improvement districts. The supervision and control over the issuing of bonds by the districts were placed with the boards of county commissioners. As this feature proved to be unsatisfactory, particularly in the marketing of the bonds, the law was amended in 1909, so as to place the control of bond issues with the district courts. Under this law several districts have been organized, but it is estimated that with the advantage of a single regulating board, working with the advice and assistance of the state engineer, as provided by the law, opportunities for development under the irrigation district plan will be greatly extended.

The new law enables the owners of land under an irrigation system owned by other parties to purchase the property, using the district bonds for payment, and thus secure direct and cooperative control at once. By the use of the serially maturing bonds the expense of the purchase or the new construction can be distributed over the years when the benefits are being derived, the expense for both the interest and principal for taking up the bonds at maturity being levied in the form of a tax against the land and paid in annual installments. This method also enables the owners of land with direct-flow rights which are not sufficient in all seasons, to form their lands into a district for the purpose of constructing storage works to provide a supplemental water supply. In these cases the expense per acre is usually small, and as the security is in the lands already improved the bonds may become a first lien on property several times its value.

It is in these two ways that the law has been applied in the past. Under the Irrigation Commission it is expected that in the future it may be used for the development of water supplies for sections that have heretofore been cultivated under the dry farming system where the need for supplemental irrigation systems has been particularly felt during the past dry years. A higher duty than is used at present is probable and such lands will have their improved dry-farming values as security for the bonds.

Irrigation beyond a doubt is the best crop insurance and it has been found to pay even though water is used only once in five years. The unusual number of homestead entries in Montana has been breaking

up the areas which might ultimately be developed under the Carey Act and it is expected that to a certain extent the district method may take the place of the Carey Act system.

STATE SURVEY.

So many inquiries and requests for preliminary investigations of water supplies, reservoir sites, irrigable areas, etc., came to the commission that it soon became apparent that general information of this nature of the state was imperative. Accordingly during the summer of 1920, the Commission made an irrigation survey, taking each county separately. Data were gathered on the areas now under irrigation; areas which are proposed to be developed, areas which could be put under irrigation, undeveloped reservoir sites, available water supplies, pumping possibilities, etc. Owing to the limited time and funds the information was gathered from the court records, county officials, irrigators, ditch superintendents, pioneers, etc. Under the circumstances, the results are as near correct as it was possible to obtain.

The survey reveals the fact that many small pumping plants operating under low lifts for the irrigation of small areas, are quite numerous. The development of larger pumping plants is beginning to receive considerable attention, but to date there are comparatively few in operation. The chief question involved is "how high can water be pumped profitably?" Many conditions affecting the answer to this question arise, such as the quality and value of crops that can be raised, transportation facilities, markets, cost of power, duty of water, and many other contingencies. It can readily be seen that it might pay to pump water 150 feet along the Yellowstone Valley, for example, where the growing season is long, the crop returns are high and transportation facilities are good, whereas a similar plant located in the mountainous section at a much higher altitude, where the season is half as long, railroads are remote and stock raising is the principal industry, would not pay. The best solution to such a problem is to work out the results for each individual case. As for example, suppose dry land worth \$20 per acre is to be irrigated by a pumping plant costing \$36 per acre and the yearly maintenance cost is \$10 per acre, then the project must be made to pay a fair rate of interest (8%) on

Original value of dry land	\$20 per acre
Cost of irrigation works, \$36 per acre. If bonds sell for 90%	40 per acre
Improvements on land preparatory to irrigation	20 per acre
Total investment	\$80 per acre
As a safe investment the return on the irrigated land must pay:	
Interest on the investment, 8% of \$80	\$ 6.40 per acre
Taxes, 2% of \$80	1.60 per acre
Yearly maintenance cost of pumping	10.00 per acre
Int. on Maint. warrants, 4 mo. 6% on \$1015 per acre
Total	\$18.15

The irrigated land must produce a net yearly income of \$18.15 per acre to pay interest on the investment and the maintenance. Depending upon the locality, the markets, crops, etc., it is a matter of figures to compute the net return on irrigated land to determine whether or not the project will pay.

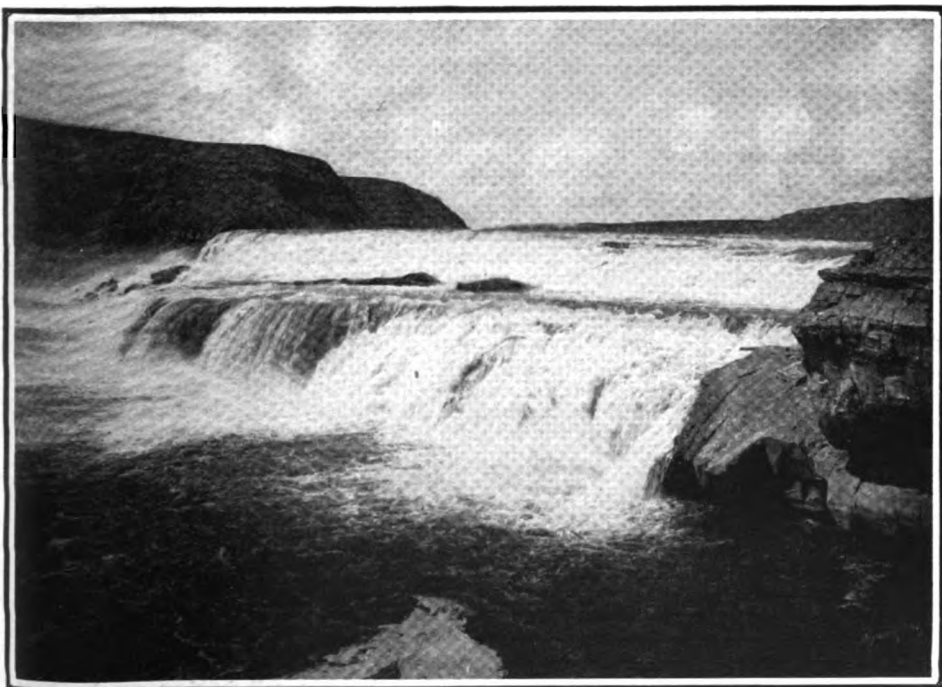
Many natural lakes and artificial reservoirs have been developed, but there are still many more that will be built in the near future. These reservoirs will serve the double purpose of holding flood waters in reserve for irrigation during the summer, as well as checking the destructive floods along the streams in the early spring. The records

show that at least 42,000,000 acre feet of water leave the state annually in the Missouri, Yellowstone and Clark's Fork rivers. By building reservoirs for the conservation of these flood waters, assuming that it could all be stored, it would be sufficient to irrigate 14,000,000 acres at a duty of three acre feet per acre, or in other words, the water supply is sufficient to increase the present irrigated acreage four times. Unfortunately, about one-third of the water supply originates on the western side of the continental divide where the water far exceeds the arid agricultural land.

IRRIGATION STATISTICS.

Montana contains 93,000,000 acres of land of which two-thirds are classified as forests and grazing and the other one-third agricultural land. The following table shows the results of an irrigation survey made in 1909 by the Montana Agricultural College Experiment Station (Bulletin No. 103) and also the results of the irrigation survey of the Commission made in 1920. The figures show the acreages of land actually under irrigation.

	1909.	1920.
Irrigation Districts	412	51,698
Other Enterprises	1,587,530	1,839,576
U. S. R. S. and Indian Service	81,494	145,000
Carey Act Projects	9,648	100,700
Total	1,679,084	2,136,974



A Wealth of Water Going to Waste

As a result of the survey by the Commission the additional area that can be irrigated by works being constructed or works constructed but not in use, and irrigation districts or private or corporate enterprises organized for beginning construction are:

Irrigation districts under the court	375,747
Irrigation districts under the commission	122,136
Other enterprises	103,360
U. S. R. S. and Indian Service	199,000
Carey Act Projects	85,300
Total	885,543

The survey shows that 2,266,000 acres not included in any of the above figures are still susceptible of irrigation.

Following is a summary of the ultimate irrigation development in the state under the present market conditions, population, land values and duty and use of water:

Area now being irrigated	2,136,974 acres
Works already contemplated or districts organized	885,543 acres
Additional area that can be irrigated	2,266,000 acres
Total	5,288,517 acres

A general summary of the irrigation districts before the Commission and the results of the state irrigation survey, by counties, follows:

PROJECT NO. 1.

Cooper's Lake Irrigation District, Powell County.

Location, Blackfoot Valley. Elevation, 4,300 Feet. Total Area, 20,000 Acres. Petition Filed, October 18, 1919. Deposit Requested, \$300.00. Estimated Cost, \$40.00 per Acre.

This proposed project is located in Powell County, in the western part of the state in the Blackfoot Valley on the Pacific slope of the continental divide. The land proposed to be irrigated is situated between the North Fork and the main Blackfoot River and is locally known as "Kleinschmidt Flat". The town of Ovando lies some six to ten miles west and Helmsville is some ten miles south. The estimated area to be irrigated is 20,000 acres.

It is proposed to divert water out of the North Fork of the Blackfoot River just below the junction of the Blackfoot River and the Dry Fork, and carry the water down the canyon by ditch and flume crossing the divide and emptying the water into the Cooper's Lake drainage area. A dam is to be built at the foot of Cooper's Lake for the storage of flood water and the control of water during the irrigating season. From the lake, water will be distributed over the land by a system of canals and laterals. The establishment of a power plant in the canyon below the Cooper's Lake dam is also a possibility. The lower part of this project is higher than the surrounding country and somewhat rolling and it is proposed to transmit power to Brown's Lake, which lies at the foot of this bench, and from there pump water up to the higher levels.

The body of land is a long triangular alluvial fan, wedged between the mountains, which has been formed by the wash of the North Fork. The upper part is very flat with a good slope to the south. The lower part along the main Blackfoot River is higher than the surrounding country and has the appearance of a glacial moraine formation. The soil on the upper part of the flat is chiefly a sandy gravelly formation which indicates that a heavy seepage of irrigation water can be expected. The bench land is composed of a heavier soil having an indication of a clay formation. The whole area is free from stumps,

trees, large boulders and brush. There are comparatively few farmers living on the area. Most of it is fenced and about half of it has been farmed at various times. The community at the present time is not very prosperous, but there are good possibilities of building it up through irrigation into a thrifty settlement. The proposed line of the Chicago, Milwaukee and St. Paul Railway, connecting Great Falls and Missoula, crosses through the center of the project and the location is practically assured, as most of the right of way has been purchased and some of the road bed has been graded.

An informal petition, signed by eighteen land owners of the proposed district, representing 11,610 acres, was filed August 16, 1919, with the clerk of the court, Powell County, and also with the secretary of the Montana Irrigation Commission. A preliminary investigating trip was made over the main features of the project and the state engineer rendered an estimate of \$300 as the money needed to carry on the engineering investigation and report on the water supply, cost and feasibility. A meeting of those interested was called at Helmville on October 18, 1919, for the purpose of raising the money. So many were away at the time, working in other places and out on hunting trips, that it was decided to withhold taking any action until such time as a more representative crowd could be got together.

Owing to the comparatively high elevation (4,300 feet) and the short growing season, haying, dairying and stock raising are the chief industries. Across the river in Nevada Valley, are some good examples of very prosperous farms under irrigation, which have the same climatic conditions and elevation as the Cooper's Lake project and which show what could be expected if this project were developed.

Without having made a thorough investigation, it is hard to estimate what the cost of this project may be, but from previous experience with other projects, it is probable the cost should not exceed \$40 per acre.

PROJECT NO. 2.

Nine Mile Prairie Irrigation District, Missoula County.

Location, Blackfoot Valley. Elevation, 3,600 Feet. Total Area, 9,000 Acres. Petition Filed, August 10, 1919. Deposit Requested, \$300. Cost, \$25 to \$30 per Acre.

This proposed project is located in Missoula County in the western part of the state in the Blackfoot Valley on the Pacific slope of the continental divide. The land proposed to be irrigated is located along the north side of the Blackfoot River, extending from the mouth of Clearwater River down nearly to the mouth of Belmont Creek. The strip of land is locally known as "Nine Mile Prairie". The town of Potomac lies some eight or ten miles southwest. The estimated area to be irrigated is 9,000 acres.

It is proposed to divert the water by a gravity system out of either the Clearwater or the Blackfoot rivers depending upon which proves to be the more feasible. The water will be distributed upon the lands by a system of canals and laterals.

The land to be irrigated is a flat area along the valley bounded on the south by the Blackfoot River and on the north by a range of high mountains. It has a good drainage to the west and south. It is a sandy, gravelly soil susceptible of heavy seepage. Many large boulders form a narrow fringe around the east and south edges. There are no stumps, trees or brush on the land. The elevation is 3,600 feet above sea level.

There are comparatively few farmers living on the land and most of the area is being used for pasture, although a small part is being dry farmed. The proposed line of the Chicago, Milwaukee and St. Paul Railway, connecting Great Falls and Missoula, crosses the project. The right of way has been purchased and most of the road bed graded from there to Missoula.

An informal request on behalf of land holders was filed with the Montana Irrigation Commission on August 19, 1919, asking for an investigation of the feasibility and cost of the project. A preliminary trip was made over the proposed district and the state engineer made an estimate of \$300 as the amount needed to make the necessary engineering investigation. The deposit has not been made with the Montana Irrigation Commission.

This project is very feasible both from the standpoint of the quality of the land and the water supply. There are no unusual or costly engineering features and the maintenance cost of operation should be very reasonable. Without having made a thorough investigation it is hard to estimate what the project may cost, but from experience with other projects it is not likely it would amount to more than \$25 or \$30 per acre.

PROJECT NO. 3.

Frenchtown Valley Irrigation District, Missoula County.

Location, Frenchtown Valley. Elevation, 3,100 Feet. Total Area, 8,000 Acres. Petition Filed, October 11, 1919. Deposit Requested, \$450. Cost, \$24.61 per Acre.

This proposed project is located in Missoula County in the western part of the state on the Pacific slope of the continental divide. The land proposed to be irrigated is situated along the north side of Clark's Fork of the Columbia River, extending from a point eight miles above Frenchtown down to the town of Huson in what is locally known as "The Frenchtown Valley". The estimated area to be irrigated is 8,000 acres.

It is proposed to divert water out of the Clark's Fork of the Columbia River some eight miles below Missoula and distribute the water over the lands by a gravity system of canals and laterals. A small dam will be required across one branch of the river near the diversion works. The valley is very fertile bottom land, free from rocks and stumps. There are narrow fringes of brush along the water courses and several small patches of scattering timber, but the bulk of the land is cleared and is being successfully dry farmed. Comparatively, the area is thickly settled with prosperous farmers of French descent. The town of Frenchtown is situated near the center of the project. Both the main line of the Chicago, Milwaukee and St. Paul Railway and the Couer d'Alene branch of the Northern Pacific Railway cross the project. The growing season ranges from one hundred to one hundred and twenty days, and the altitude is 3,100 feet. The annual precipitation varies from twelve to eighteen inches. The chief crops are grain, hay, and dairying and stock raising are the principal industries.

An informal petition, signed by six land owners in the district, was filed with the Montana Irrigation Commission, October 11, 1919. Representatives of the Commission made three informal trips over the project and attended a meeting held at Frenchtown, July 18, 1920, for the purpose of encouraging and assisting in the organization of the district. The state engineer rendered an estimate of \$450 as the amount needed in making an engineering investigation of the cost, feasibility and so forth. The deposit has not been made with the Montana Irrigation Commission.

The district employed an eminent irrigation engineer from Oregon to make the preliminary surveys and estimate the cost. His findings show that the total cost of the project will be \$196,867.20, or \$24.61 per acre.

It is to be a gravity system, having no unusual or costly engineering problem. The land is very fertile and productive; the water supply is plentiful, and the community is prosperous, so there is no reason why this should not be a very feasible project. In fact, it is one of the most feasible projects that has come to the attention of the Commission.

PROJECT NO. 4.**DeSmet Irrigation District, Missoula County.**

Location, Missoula Valley. Elevation, 3,200 Feet. Irrigable Area, 4,927 Acres. System, Pumping by Electric Power. Lifts, 131.3 Feet and 70.8 Feet. District Created January 3, 1920. Cost of investigation, \$209.11. Total Cost Project, \$197,004.50. Cost per Acre, \$39.98. Yearly Maintenance Cost, \$4.47.

This project is located in Missoula County five miles northwest of Missoula on the Pacific slope of the continental divide. The area to be irrigated is a high gently rolling strip of bench land, locally known as the "DeSmet Bench".

It was found that three sources of water supply were possible for this project, the Blackfoot River, Rattlesnake Creek and the Clark's Fork of the Columbia River. The first two could be diverted by gravity and the third by a pumping scheme. The pumping scheme was further divided into three propositions. In order to investigate thoroughly this project and make a complete report covering all the possibilities, it was necessary to take up each scheme and work it out independently of the others, then prove the conclusions of each and arrive at the best and most feasible one. This work was done during a part of October, November and December, 1919.

The first source investigated was to divert water by gravity out of the Blackfoot River near Bonner. This scheme was given up as not practical. A long ditch line would be needed along steep banks, and this would interfere with highways and railroads and would cross through the city of Missoula, also the headworks would be interfered with by logging operations at Bonner.

The second source investigated was a gravity canal out of Rattlesnake Creek. It was found that the normal flow of the stream had all been appropriated and flood waters would have to be depended upon. Two good reservoir sites were found but the cost of development prohibited this scheme of irrigation for a project having so small an acreage.

These two sources of water supply proving not feasible, the only other alternative was the Clark's Fork River, the water to be delivered by pumping. It was assumed that electric power would be available from the Missoula Light and Water Company. Three different pumping schemes seemed possible and each was investigated and computation was made of the costs.

They first proposed locating the pumping plant on the river at the mouth of Rattlesnake Creek and lifting water 63.9 feet net to the main canal. Where the main canal enters the irrigable area, a second pumping plant would be installed to lift water 60 feet net for the upper land area. This scheme involved the upkeep of two pumping stations about five miles apart and an expensive ditch line through the city limits so it was abandoned as not feasible. Under this plan the total estimated cost was \$215,199.60, or \$43.68 per acre.

The second system was the same as the first only the main pumping plant would have been located near the lower edge of the city limits. This would have reduced the expensive canal upkeep through the city limits, but on the other hand 6,500 lineal feet of pressure pipe were required to deliver the water from the pumps to the main canal and the objection of keeping up two pumping plants still obtained. This scheme was abandoned. The total estimated cost was \$213,578.20, or \$43.35 per acre.

The third and most feasible of all the schemes was to enlarge about three miles of the present Flynn-Lowney ditch and extend it to the foot of the DeSmet bench near the old Hollenbeck brick yard and from there pump water onto the bench. Only one pumping station having two units would be needed. The low lift is 70.8 feet net and covers an irrigable area of 2,852 acres, and the high lift is 131.3 feet net and

covers an irrigable area of 2,075 acres. The total irrigable area under the two lifts is 4,927 acres. The total estimated cost of this scheme is \$197,004.50, or \$39.98 per acre. The estimated annual maintenance cost is \$4.47 per acre.

The connected power required to handle the peak load for the low line pump is 544 horsepower and the annual consumption of power is 342 horsepower. For the high line pump the connected load and power consumption are 693 horsepower and 435 horsepower respectively. This makes a total connected load of 1,237 horsepower and a total annual consumption of 777 horsepower. The pump capacity for the low lift is 76.12 second feet, and for the high lift 32.06 second feet.

The duty of water under the first two systems is 2.5 acre feet per acre per season, while under the third it is 2.31 acre feet. The maximum duty of 0.95 acre feet comes in the month of July. The length of the irrigating season is 120 days.

The estimated payment to be made by the farmers the first year, including the sinking fund, interest on the bonds and the annual maintenance charge, will be \$8.87 per acre figured on a basis of twenty year payments. This amount will gradually decrease from year to year until the twentieth or last year, when the assessment will be \$4.53 per acre, and after that only the maintenance cost of \$4.47 per acre will be assessed.

The petition asking for the creation of the district was filed October 8, 1919. The engineer's report and the recommendations of the Montana Irrigation Commission were filed December 12, 1919, and the district was created by the District Court, January 3, 1920. The amount of the deposit requested to cover expenses of making the investigation



Oats Raised by Irrigation

and report was \$300. The actual cost was \$202.11 and the balance of \$97.89 was returned to the petitioners. The number of land owners in the district is thirty-seven and twenty-four signatures are on the petition. The gross acreage in the district under the canals is 5,712.3 acres.

The soil ranges from a narrow strip of coarse gravel along the higher elevations to a clay and sandy loam on the lower benches. The subsoil is clay. Practically all of it has been successfully dry farmed. The soil is rich and well adapted to raising grains, alfalfa, fruit, sugar beets and garden truck. The altitude is 3,200 feet above sea level. The climate is mild in winter and moderate in summer. The yearly precipitation ranges from twelve to eighteen inches. The growing season is from May 15th to September 15th. The project is crossed by the main line of the Northern Pacific Railway and the Coeur d'Alene branch. The main line of the Chicago, Milwaukee and St. Paul Railway is two miles south of the project. The water supply is plentiful and electric power is within two miles. By the addition of water to the land, this project should make a prosperous community, but owing to the nature of the scheme a scientific and businesslike management will be the prerequisites to make this project a success.

PROJECT NO. 5.

Glendive-Fallon Irrigation District, Prairie and Dawson Counties.

Location, Yellowstone Valley. Construction Cost, \$26.87 to \$46.89 per Acre. Maintenance Cost, \$6.38 to \$12.81 per Acre. Irrigable Area, 4,255 to 22,475 Acres. Coal Consumption, 7,240 to 47,737 Short Tons. Deposit Required, \$1,400. Cost of Report, \$1,309.95. Elevation, 2,150 Feet. Land Owners in District, 125. Gross Area District, 34,440 Acres.

This project is located in both Prairie and Dawson counties along the Yellowstone River Valley in the eastern part of the state. Most of the district is situated in Dawson County. The bulk of the land to be irrigated lies along the north side of the river and extends from the town of Fallon down to a point three and one-half miles northeast of the town of Stipek. The area on the south side of the river, surrounding the town of Fallon and known as "Fallon Flat" is in the project and the boundaries also include a section on the north side two miles due west of Fallon.

It is proposed to divert water out of the Yellowstone river by pumping, using steam power generated by local lignite coal. A pumping plant was built some eight or nine years ago on the north bank four miles east of Fallon. It is proposed to enlarge this plant for handling the irrigable area on the north side of the river and generating and transmitting electrical current for pumping on the south side.

Investigation of this project revealed the fact that there was a possibility of covering the area by a gravity ditch diverting water out of the Yellowstone River near Miles City. Surveys proved this scheme to be too expensive and not practical for a project of this size.

The tract to be irrigated is a long narrow strip averaging about two miles wide from the river to the foot of the hills which define the river valley. The surface is flat, having a good drainage to the river. Topographical features divide the area up into four natural units and for this reason many schemes and possibilities of irrigation presented themselves which made a thorough investigation of this project a long and strenuous task. The river separates the area around Fallon from the rest of the project making that an independent unit. Half way between Fallon and Glendive high bluffs project down to the river bank, segregating the area into two parts locally known as the "Upper" and "Lower Flats". For three miles below Glendive, the bad lands break up the topography, also a difficult crossing over Deer Creek separates the "Lower Flat" from the area around Stipek, locally known as the

"Stipek Flat". Further difficulties arise on the Stipek Flat due to the land being divided into a strip of upper bench land and a much lower strip of flat river bottom land.

The field investigation of this project was begun January 2, 1920, and lasted through the balance of the winter. Most of the time the weather was very cold; snow blocked traffic along the roads so that a car could not be used; accommodations were few and far between and in fact every condition was adverse to agreeable field work.

The petition asking for the creation of the district was filed with the Clerk of the Court, Dawson County, and the Montana Irrigation Commission on October 4, 1919. There are one hundred and twenty-five land owners in the district and seventy-nine signed the petition. The gross acreage included within the district is 34,440 acres, of which 20,744 acres are signed to the petition. The engineer's report and recommendations of the Montana Irrigation Commission were filed April 28, 1920. The date of hearing was set in the court for July 30, 1920. The court, acting upon the recommendation of the Montana Irrigation Commission, dismissed the district as being not feasible in its entirety and later a new petition (See Project No. 15) was filed asking for the creation of a smaller district, which is a segregation of the original large district.

The petitioners were asked for a deposit of \$800.00 to make the investigation and report. Owing to the extent of the project and the adverse conditions under which field work had to be done, an additional deposit of \$600 was requested. The total cost of making the surveys and report was \$1,309.95 and the balance of \$90.05 was returned to the petitioners.

The report and recommendations, including maps and pictures, are neatly bound and indexed, consist of seventy-six typewritten pages and deal with every phase of the project, including climatic conditions, water supply, character of soil and topography, markets, transportation, extent and life of coal beds, history and inventory of the present pumping plant, gravity system, duty of water, and the report includes a compilation of both the construction and operating costs of nine different schemes of irrigating the area. The following are the proposed nine schemes:

(1) By pumping water at the present plant to two lifts, forty and seventy-five feet, and irrigating the "Upper Flat" only. The net irrigable area is 4,255 acres. The total estimated cost of the project is \$159,713.00 or \$37.54 per acre, and the estimated annual cost of operation is \$6.38 per acre. The capacity needed to supply the peak load is 569 horsepower. The average power used per season is 357 horsepower. The amount of coal used per season is 7,240 short tons.

(2) By adding machinery to the above scheme to generate and transmit electric current to the south side of the river and operate a pumping station there to lift water seventy feet net to cover "Fallon Flat". The net irrigable area is 5,605 acres. The total estimated cost of the project is \$204,516.00 or \$36.49 per acre and the estimated annual cost of operation is \$6.71 per acre. The capacity needed to supply the peak load is 798 horsepower. The average power used per season is 500 horsepower. The amount of coal used per season is 10,140 short tons.

(3) By adding extra machinery to the present steam plant to irrigate the "Upper Flat" by pumping to three lifts, forty, seventy-five and one hundred feet net. The net irrigable area is 6,580 acres. The total estimated cost of the project is \$283,340.00 or \$43.06 per acre, and the estimated annual cost of operation is \$7.38 per acre. The capacity needed to supply the peak load is 1,057 horsepower. The average power used per season is 663 horsepower. The amount of coal used per season is 13,445 short tons.

(4) By adding enough equipment to scheme three to generate and transmit electric current to the south side of the river to operate a pumping sub-station to lift water seventy feet net to cover the "Fallon Flat". The irrigable area is 7,930 acres. The total estimated cost of the project is \$328,143.00 or \$41.38 per acre and the estimated annual cost of operation is \$7.44 per acre. The capacity needed to supply the peak load is 1,286 horsepower. The average power used per season is 806 horsepower. The amount of coal used per season is 16,345 short tons.

(5) By adding enough machinery to scheme four to generate and transmit electric current to the upper end of the "Lower Flat" in addition to the "Upper Flat" and the "Fallon Flat". The net irrigable area is 17,650 acres. The total estimated cost of the project is \$694,930.00, or \$39.32 per acre, and the estimated annual cost of operation is \$7.83 per acre. The capacity needed to supply the peak load is 3,754 horsepower. The average power used per season is 2,354 horsepower. The amount of coal used per season is 47,737 short tons.

(6) By adding enough extra pumping machinery to scheme four to pump all the water at the present plant that will be needed for the "Upper" and "Lower Flats" to the one hundred feet net lift, and carry the water by ditch through a deep open cut or tunnel through the hill separating the two flats. The open cut would require the removal of 275,000 cubic yards. The irrigable area is 17,785 acres. The total estimated cost of the project is \$883,983.00 or \$46.89 per acre, and the estimated annual cost of operation is \$6.99 per acre. The capacity needed to supply the peak load is 3,126 horsepower. The average power used per season is 2,105 horsepower. The amount of coal used per season is 42,689 short tons.

(7) By adding enough machinery to scheme five to generate and transmit electric current to a pumping sub-station near Glendive and lift water there one hundred feet net to cover the "Stipek Flat" in addition to the "Upper" and "Lower Flats" and the "Fallon Flat". The net irrigable area is 22,475 acres. The total estimated cost of the project is \$987,434.00, or \$43.93 per acre, and the estimated annual cost of operation is \$8.87 per acre. The capacity needed to supply the peak load is 5,398 horsepower. The average power used per season is 3,441 horsepower. The amount of coal used per season is 69,781 short tons.

(8) By pumping by steam for the three lifts on the "Upper Flat" and pumping by electric current generated at the steam plant for the "Fallon Flat", and irrigating the "Lower Flat" by using electric power generated at the Glendive City plant. The net irrigable area is 17,650 acres. The total estimated cost of the project is \$492,112.00, or \$27.88 per acre, and the estimated annual cost of operation is \$9.52 per acre. The capacity needed at the steam plant to supply the peak load is 1,286 horsepower, and the Glendive plant is 2,048 horsepower. The average power used by the steam plant per season is 806 horsepower, and the Glendive plant is 1,285 horsepower. The amount of coal used per season by the steam plant is 16,345 short tons.

(9) By making the "Stipek Flat" a separate project altogether and pumping one hundred feet net by electric power generated at the Glendive City plant. The net irrigable area is 4,825 acres. The total estimated cost of the project is \$129,625.00, or \$26.87 per acre, and the estimated annual cost of operation is \$12.81 per acre. The capacity needed to supply the peak load is 1,036 horsepower. The average power used per season is 650 horsepower.

The length of the irrigation season is 130 days, the duty of water is two acre feet per acre at the pumps, and the maximum demand of 0.76 acre feet per acre comes in the month of July. From the actual results of operation of the steam plants at Glendive and Fairview, using the same grade of coal as this project proposes to use, it was found

that a conservative estimate of thirteen pounds of coal per horsepower hour would be needed. It is estimated coal will cost \$2.00 per ton at the boilers.

The results show that the first cost is less by using electric power from Glendive but the yearly maintenance cost is higher than by using power from the steam plant. The system having the cheapest yearly maintenance cost is the "Upper Flat" operating two lifts. The Commission, therefore, recommended the construction of this part of the project. Accordingly, all former court proceedings were annulled and a new petition was filed (see Project No. 15) asking for the creation of a smaller district.

A reconnaissance survey was also run to approximate the location of a gravity canal out of the Yellowstone River to irrigate this project. The first survey on the north side of the river showed this to be not feasible on account of several miles of steep river banks and bad lands. A survey was then run on the south side with the idea of syphoning across the valley below Fallon. The point of intake would be about ten miles below Miles City. Many difficult and costly engineering features would be involved so this scheme was abandoned on account of the excessive cost for a project of this size.

The water supply is sufficient; the soil is excellent for grain, hay, sugar beets, flax, corn and garden truck; the main line of the Northern Pacific Railway crosses part of the project and the main line of the Chicago, Milwaukee and St. Paul Railway is within five miles of the western end of the project. The land lies well for irrigation and the coal supply is plentiful and is located at the pumping plant. In fact, all the conditions are ideal save an economical method of diverting the water out of the river onto the land.

PROJECT NO. 6.

Brockway Irrigation District, McCone County.

Location, Redwater River Valley. Irrigable Area, 2,470 Acres. System, Flood Water Storage. Water Supply, Duck and Ash Creeks and Redwater River. Elevation, 2,500 Feet. Cost, \$76.95 to \$105.91 per Acre. Cost of Storage, \$27.06 to \$35.84 per Acre Foot. Cost of Report, \$276.35.

This project is located in McCone County along the Redwater River, a tributary to the Missouri River, in eastern Montana. The land proposed to be irrigated is a long narrow strip lying on the south and east side of Redwater River extending from Duck Creek down to the town of Brockway and also a strip on the north and west side of the river extending from Brockway down to Antelope Creek. The area is all flat with a good drainage to the river bottom. Several small coulees coursing from the upper high highlands to the river, cross the project. There are no trees, stumps, brush or rocks on the land nor anywhere on the surrounding country. The soil is an excellent sandy clay loam with a clay subsoil.

The source of water supply will be flood waters stored during the spring freshets in reservoirs to be constructed in the Redwater River, Duck Creek and Ash Creek. These streams are full during the early spring when snow is melting, but they are practically dry during the irrigating season. The Sheep Mountains form the watershed for these streams. The watershed is mostly covered with a thick growth of bunch grass, devoid of timber, and comparatively low in altitude. Unfortunately for this project the state has never carried on the work of measuring any streams within the watershed, nor have any streams in that section of the state been gauged which would form a good basis of comparison for the Redwater drainage area. The only data obtainable for forming any kind of estimate of the available water supply that could be depended upon for this project were a private dam and reservoir built eleven years ago on Wolf Creek, a tributary of the

Redwater sixty miles below Brockway. The capacity of this reservoir is 3,588 acre feet and the drainage is 86 square miles. No trouble has ever been experienced in filling the reservoir. Comparing the stream of the Brockway district with this, there is plenty of water for the project. Another comparison was made with data obtainable on the flow of Poplar River and this shows the water supply of the Brockway district is insufficient. The comparison is not a fair one, however, as the records are incomplete and the character of the drainage areas is not the same. There are five proposed reservoirs to supply the project: Reservoir No. 1 and Reservoir No. 2 are located on Duck Creek five miles southwest of Brockway; Reservoir No. 3 is located on Ash Creek one mile southeast of Brockway; and Reservoir No. 4 and Reservoir No. 5 are on the Redwater River four miles above Brockway. Deep and well-defined clay banks define the stream courses. On account of the absence of other building material, the dams will all have to be earth fill placed by machinery. The following are the data on the dams and reservoirs:

RESERVOIR NO. 1. Duck Creek drainage area, 64 square miles; length of dam at the top, 1,175 feet; maximum height of dam, 37 feet; storage capacity of the reservoir, 2,736 acre feet; surface area of reservoir when full, 157.28 acres.

RESERVOIR NO. 2. Length of dam at the top, 1,115 feet; maximum height of dam, 26 feet; storage capacity of the reservoir, 1,172 acre feet; surface area of reservoir when full 96.87 acres.

RESERVOIR NO. 3. Ash Creek drainage area, 45 square miles; length of dam at the top, 530 feet; maximum height of dam, 30 feet; storage capacity of the reservoir, 1,469 acre feet; surface area of reservoir when full, 116.21 acres.

RESERVOIR NO. 4. Drainage area of Redwater River, 156 square miles; length of dam at the top, 1,675 feet; maximum height of dam, 30 feet; storage capacity of the reservoir, 2,485 feet; surface area of reservoir when full, 247 acres.

RESERVOIR NO. 5. Combined drainage area of Duck Creek and Redwater River, 220 square miles; length of dam at the top, 898 feet; maximum height of dam, 19 feet; storage capacity of the reservoir, 1,350 feet; surface area of reservoir when full, 153 acres.

It is very probable that the drainage area of Duck Creek will not be sufficient to fill reservoirs Nos. 1 and 2 so that it is proposed to supply the deficiency from Redwater River by a supply canal 29,000 feet long.

Estimates of the costs of the reservoirs are as follows:

	Total Cost.	Cost per Acre Foot of Water Stored.
Reservoir No. 1.....	\$90,360.00	\$33.02
Reservoir No. 2.....	42,000.00	35.84
Reservoir No. 3.....	39,756.00	27.06
Reservoir No. 4.....	75,876.00	30.53
Reservoir No. 5.....	38,477.00	28.50

All the reservoirs are not needed to supply the water required for the project so that many combinations of reservoirs are possible. Estimates of costs were made in the report on nine different schemes as follows:

Reservoir No.	Total Cost.	Cost per Acre.
1, 2, 3,	\$228,168.00	\$90.57
1, 2, 4,	264,288.00	96.45
1, 3, 4,	238,812.00	87.16
1, 2, 3, 5	266,645.00	97.32
2, 4,	135,396.00	99.04) Proposed Irrig.
3, 4,	133,152.00	97.40) area on north
2, 3, 5,	137,753.00	100.77) side of riv. only.
1, 3,	145,416.00	105.91) Proposed Irrig.
1,	105,660.00	76.95) on south side only.

The Commission, in its recommendations, advised that stream gauging stations be established along the streams and that dependable data on the water supply be compiled before going further with this project. Upon this item depends the feasibility of the project and it may also alter the estimated costs. Also, it was advised that interest in the project be kept alive and the scheme not dropped. Measurements were taken of the flow of the water in Duck Creek and Redwater River during the investigation work and four staff gauges were placed on bridges, one at Ash Creek, two on the Redwater River and one on Duck Creek. It is hoped these gauges will be cared for and read during the flood periods.

The petition asking for the creation of the district was filed with the clerk of the district court, McCone County and also the secretary of the Montana Irrigation Commission on October 18, 1920. There are nineteen land owners in the district and eleven signatures to the petition. The gross area of the district under the canal on the north and west sides of the river is 1,621 acres out of which 1,367 acres net are irrigable, and the gross area in the district under the canal on the south and east sides of the river is 1,632 acres, out of which 1,373 acres net are irrigable. This makes a total gross area within the district and under the canals of 3,253 acres, and a total net irrigable area of 2,740 acres.

The amount of the deposit required to make the field investigation and report was \$600; the work cost \$276.35 and the balance of \$323.65 was returned to the petitioners. The field work was done during May, 1920, and the report with the recommendations of the Montana Irrigation Commission was filed August 26, 1920. The report, including maps and pictures, is neatly bound and covers forty-four pages.

Soil under this project is excellent for growing hay, grain, flax, alfalfa and corn. Native bunch grass grows as well here, if not better, than in any other section of the state and the locality was one of the favored feeding grounds of the wild buffalo. It is comparatively a new settlement, most of the land being homesteaded within the past ten or fifteen years. Outside of the town of Brockway—one hundred population—there are about thirty people living within the project. The elevation is approximately 2,500 feet above sea level. The water supply is questionable. The nearest railroad is about forty miles, but the proposed extension of the Great Northern into Great Falls traverses the entire length of the project. By the extension of the railway and the application of water to the land, the Brockway district has promises of being one of the thrifty communities of the state.

PROJECT NO. 7.**Valley View Irrigation District, Broadwater County.**

Location, Four Miles West of Three Forks. Elevation, 4,200 Feet. Irrigable Area, 3,037 Acres. System, Pumping Electric Power. Water Supply, Jefferson River. Lifts, 89.5, 136.5 and 185 Feet Net. Total Connected Power, 862 H. P. Yearly Power Used, 1,368,244 K. W. H. Cost Construction, \$21.09 per Acre. Yearly Maintenance Cost, \$6.03 per Acre. Cost of Report, \$286.64.

This project is located in Broadwater County along the west side of the Jefferson River on the Atlantic slope of the continental divide. The junction of the Madison, Jefferson and Gallatin rivers which forms the headwaters of the Missouri River is five miles northeast. The town of Three Forks is four miles east of the project. The land to be irrigated is a strip of flat bench lying adjacent to and from twenty to fifty feet higher than the river. The drainage is toward the southeast and the area lies in one solid compact body. The elevation is 4,200 feet above sea level.

It is proposed to divert water out of the Jefferson River by pumping, using electrical power from the Montana Power Company. Power is available at Three Forks, only three miles away. The plant will be located at the southern end of the project where a very short delivery pipe line is required to deliver water to the highest elevation. At least two lifts will be installed and possibly three. There will be no costly or unusual engineering features, and there is no question about the water supply being sufficient.

The report assumes that three units will be the most economical installation. The first lift is 89.5 feet serving a net irrigable area of 811 acres; the second is 136.5 feet serving a net irrigable area of 918 acres in addition; and the third is 185 feet serving a net irrigable area in addition to the other two of 1,308 acres. The total net irrigable area under the three lifts is, therefore, 3,037 acres.

The length of irrigating season is 120 days; duty of water at the pumps is two acre feet per acre per season; the maximum demand for water is 0.76 acre feet per acre during the month of July. The power required to handle the peak load for the first lift is 142 horsepower; for the second lift, 245 horsepower; and for the third lift, 475 horsepower, making a total connected load of 862 horsepower. The amount of power consumed per season by the first lift is 225,758 kilowatt hours; by the second lift, 389,996 kilowatt hours and by the third lift, 752,490 kilowatt hours, thus making the total consumption of power for the three lifts per season, 1,368,244 kilowatt hours.

The total estimated costs of construction and operation for the combinations of lifts are as follows:

Lifts	Irrigable Areas	Construction Cost		Maintenance Cost Per Year	
		Total	Per Acre	Total	Per Acre
1st only	811	\$25,254	\$31.14	\$ 5,981.60	\$7.37
1st and 2nd	1,729	40,330	23.32	10,579.89	6.12
All three	3,037	64,049	21.09	18,326.98	6.03

The estimated cost to the farmer to pay off the sinking fund, interest on the bonds, and the yearly maintenance cost, figured on a basis of twenty year payments, will be for the first year \$8.34 per acre, the twentieth year \$7.14 per acre and \$6.03 per acre per year for each year thereafter.

The original petition asking for the creation of this district was filed with the clerk of the district court, Broadwater County, and the secretary of the Montana Irrigation Commission on January 7, 1920. The field investigation was done during February, 1920, and the report and recommendations of the Commission were filed April 19, 1920. Upon the court hearing of the petitioners, it was discovered that the abstract of title of the signers was in error in many instances so all the proceedings up to this time were annulled and a new petition signed

and filed on June 18, 1920. The new petition includes twenty-seven land owners in the district out of which twenty-five are signed up. The gross area of the project as signed in the petition is 6,560 acres out of which 3,037 acres net are irrigable. The Commission had to withdraw its first report to the district court and the second report was filed on July 22, 1920. A deposit of \$300 was asked for the necessary field work and report. The actual cost was \$286.64 and the balance of \$13.36 was returned to the petitioners. The hearing on the new petition was set for August 30, 1920, on which date the district was formally created and three local men were appointed for commissioners. Mr. Fred Brown of Bozeman was appointed engineer for the project and his contract with the district has been submitted to and approved by the Montana Irrigation Commission. The detail work is now in progress preparatory to selling the bond issue and calling for bids for the construction work. The report and recommendations of the Montana Irrigation Commission, including maps, and subject matter, are neatly bound and indexed and consist of thirty-three pages.

The soil on this project is a light and sandy clay loam rich in lime. It will raise hay, grain, alfalfa, vegetables and in fact all crops suited to that altitude and climate will do well. There are no trees, stumps, brush or rocks any place within the district. The commendable features of this project are a good pump location, a short delivery pipe line, the land is all in one solid compact body, and the water will be delivered directly from the pumps to the land. By scientific and businesslike management, this project should be a success.



Natural Mountain Reservoir

PROJECT NO. 8.**East Bench Irrigation District, Beaverhead County.**

Location, Near Dillon. Elevation, 5,000 to 5,200 Feet. Irrigable Area, 13,900 Acres. System, Gravity and Storage. Source, Beaverhead River and Grasshopper Creek. Reservoir, 554 Acres, 21,316 Acre Feet. Dam, Concrete Arch, 105 Feet High. Tunnel, Solid Rock, 675 Feet Long. Syphon, 560 Feet. Cost, \$54.18 per Acre. Deposit, \$400.00. Petition Filed, March 6, 1920.

This project is located in Beaverhead County, along the Beaverhead river, a tributary of the Jefferson river, in the southwestern part of the state. The area to be irrigated is a strip of bench land lying east of the Beaverhead river and extending from a point seven miles above Dillon down to a point thirteen miles below or to the boundary line between Beaverhead and Madison counties. The bench rises some twenty to forty feet abruptly from the river valley and ascends gradually up to the foot of a high range of mountains. There is good drainage to the river. Most of the land is flat cut by occasional large coulees.

It is proposed to divert water out of the Beaverhead river, by a gravity canal, at Daly's spur, which is about twelve miles above Dillon and bring it down the rocky canyon by ditch and flume to the "Beaverhead Rock" and there a tunnel 675 feet will have to be drilled through solid rock; a reinforced concrete arch dam 105 feet high will be required and a syphon 560 feet long is needed to cross the canyon. Several small flumes or syphons may be needed to cross some of the deep coulees along the irrigable area.

The surface area of the reservoir when full will be 554 acres; the capacity is 21,316 acre feet. It is estimated that the duty of water at the reservoir will be 2.49 acre feet per acre. There will be fifty miles of main canal.

Following are the estimated costs:

Item.	Total Cost.	Cost per	Cost per.
		Acre.	Acre Foot.
Dam	\$187,096.00	\$13.46	\$8.78
Canals	531,523.00	38.22	
Tunnel	14,543.50	1.05	
Syphon	7,788.00	0.56	
Engineering, Contingencies, etc.	12,151.50	.89	
Totals	\$753,102.00	\$54.18	\$8.78

The petition asking for the creation of this district was filed with the Clerk of District Court, Beaverhead County, and also the Secretary of the Montana Irrigation Commission, March 6, 1920. The gross area as described in the petition is 25,000 acres, after making deductions 13,900 acres remain which can be irrigated. There are 78 land owners in the district and 30 are signed up. The Commission asked for a deposit of \$400 to make the preliminary surveys and report. The field work was done during July and August, 1920. The report and recommendations of the Commission have not been completed and filed for the reason that the petitioners asked to have it withheld until they could file a new petition in which the boundaries of the district will be slightly changed from the original and also a few names of title land owners corrected.

The soil generally is a rich sandy clay loam mostly underlaid with a clay subsoil. It will be very productive when irrigated as is shown by a small acreage within the project and along Blacktail Deer Creek which is now being irrigated out of the creek.

The altitude ranges from 5,000 to 5,200 feet above sea level. The county is primarily a stock raising country. Owing to the high altitude the principal commodities will be limited to hay, grain, dairy products and stock. The Oregon Short Line Railroad connecting Butte with Salt Lake affords transportation.

PROJECT NO. 9.**Harlowton-DuRand Irrigation District, Wheatland County.**

Location, Bench North of Harlowton. Elevation, 4,100 Feet. Net Irrigable Area, 16,304 Acres. Source Water Supply, Musselshell River. System, Storage of Flood Water. Total Reservoir Capacities, 27,204 Acre Feet. Total Construction Cost, \$417,700. Cost per Acre, \$56.17. Cost of Making Report, \$401.19.

This project is located in Wheatland County in the Musselshell Valley on the Atlantic slope of the continental divide. The body of land lies on a high bench adjacent to and north of the town of Harlowton. Generally, the topography is somewhat rolling with large flat areas predominating. There is a good drainage to the Musselshell River. Several coulees and flood water courses cross the land area. The soil is sandy clay showing a heavy lime deposit.

It is proposed to conserve the flood waters of both the North and South Forks of the Musselshell River and tributaries for irrigation. The main storage is the DuRand reservoir, located near the headwaters of the North Fork. Besides conserving the flood waters of the North Fork drainage area, waters from Checkerboard and Spring Creeks, which are tributaries emptying in below the reservoir site, will be diverted through canals into the DuRand reservoir. Also, a diversion canal will be built to divert water from the Smith River watershed and empty it into the North Fork above the reservoir site. The Spring Creek diversion canal will be seven and one-quarter miles long and will cross three divides; the Checkerboard will be four miles long and cross one divide; and the Smith River canal will be seven miles long and cross one divide. Another reservoir will be built at the three forks of Cottonwood Creek, a tributary to the South Fork. Two other reservoirs will be built on the flat along the main diversion canal line, one being between the North and South Forks, two miles north and west of Martinsdale and the other six miles northeast of Martinsdale.

The headwork of the main diversion canal is on the South Fork, three miles west of Martinsdale. It crosses the North Fork three miles north of Martinsdale and courses easterly to the land to be irrigated. At the junction of the two river forks, measurements of the run-off show there is enough flood water going to waste to irrigate 33,500 acres of land. The unfortunate feature of this project is that while the flood water supply is more than sufficient the storage sites are the limiting features. The DuRand reservoir has a capacity greater than the water supply available and the other reservoirs are not large enough to store all the water tributary to them. It is proposed to supply twenty-nine per cent of the water need in the early spring directly from the river and the other seventy-one per cent used during the summer when the river is low, will have to be supplied from the reservoirs.

All the dams will be earth fill, but the DuRand will have a concrete core wall. Two of the dams can be placed by hydraulic sluicing and the other two will have to be placed by machinery.

The storage capacities of the reservoirs and their estimated costs are:

Reservoir	Capacity Acre Feet.	Total Cost.	Cost per Acre Foot Storage.
DuRand	20,000	\$185,496	\$ 9.27
Cottonwood Forks	1,235	33,064	26.77
Martinsdale First	4,189	132,055	31.52
Martinsdale Second	1,780	67,085	37.69
Totals	27,204	\$417,700	

The estimated costs of the other items of construction are:

Main Canal and Laterals	\$370,284	\$22.71
Checkerboard Canal	33,394	2.05
Spring Creek Canal	56,876	3.49
Smith River Canal	37,524	2.30
Reservoirs	417,700	25.62
Totals	\$915,778	\$56.17

The grand total cost of the project is estimated to be \$915,778.00 or \$56.17 per acre figured on a basis of 16,304 acres irrigable, which is the limit of land that can be irrigated from the water supply and reservoir capacities. Assuming that the bond issue is for twenty years, the assessments against the land to pay the interest on the bonds and to provide a sinking fund to retire the bonds when due, will be \$6.26 per acre the first year. This amount will decrease each year until the last payment on the twentieth year when it will be only \$3.05 per acre. In addition there will be a small annual maintenance charge.

The duty of water is figured at 2.21 acre feet per acre per season at the head of the canal and 2.35 acre feet per acre in the reservoirs. the maximum demand will be forty per cent in July. The average length of irrigating season is 110 days. The annual precipitation ranges from 8.75 inches to 12.63 inches. The elevation averages 4,100 feet above sea level.

Unfortunately there is more good land within the district than can be irrigated. An extra effort was made in the investigation to locate additional reservoir sites that would be feasible. The watersheds of both the North and South Forks and tributaries were examined and several other sites found and surveyed, but either their cost or location within the drainage area was prohibitive.

The petition asking for the creation of this district was filed on March 17, 1920, with the clerk of the district court, Wheatland County, and the secretary of the Montana Irrigation Commission. There are ninety-three land owners within the district representing a gross area of 32,845 acres, lying under the canals. After making deductions, the net irrigable area left is 28,988 acres. There is water supply and storage capacity enough for only 16,304 acres. The part of the project lying west of Antelope Creek totals 16,590 acres irrigable, so it was recommended by the Commission in its report that the part lying east of Antelope Creek be excluded from the boundaries of the present district. The deposit made for making the preliminary surveys and report was \$600. The unexpended balance left in this account is \$98.81. The report and recommendations of the Montana Irrigation Commission were filed with the clerk of the district court, October 14, 1920. The date for creating the district will be set by the judge of the district court within the near future. The report is neatly bound and indexed. The subject matter and maps compose twenty-seven pages.

This project is located in a country which promises a good future. The town of Harlowton is the eastern terminal of the electrical division of the Chicago, Milwaukee and St. Paul railway, and the railroad connecting with Great Falls crosses through the district. Grain, hay and the dairy industry will do well. Alfalfa usually yields three crops per season in the valley. The character of the soil is excellent and the topography is well adapted to irrigation. There are no timber, stumps, brush or boulders on the project and with good management there is no reason why this project should not be a success.

PROJECT NO. 10.**Red Lodge-Rosebud Irrigation District, Carbon County.**

Location, 20 Miles Northwest of Red Lodge. Elevation, 4,700 Feet. Source of Water, East Rosebud River. System, Gravity. Weast Canal, Paid \$27,000, Ten Miles Long. Irrigable Area, 12,510 Acres. Cost Project, \$25.98 per Acre. Cost of Report, \$535.39. District Created, August 10, 1920.

This project is located in Carbon County along the north slope of the Beartooth Mountains within the Yellowstone River drainage area. The center of the project is about eighteen miles northwest of the town of Red Lodge. The land is rolling and has a drainage to the northeast. Numerous small creeks cross through the project. The creek bottoms are quite wide and high rolling benches between the creeks have many flat areas. There are many side hills too steep for irrigation and the limiting slope is fixed at twenty per cent. The soil along the upper edge is a rich black loam which gradually blends into a clay loam along the lower lands. Most of the area has a clay sub-soil.

It is proposed to divert water out of the East Rosebud River by gravity about three miles below the canyon and carry it easterly by canals and laterals along the upper edge of the project. In 1903, the Weast Brothers undertook the irrigation of part of this project and took a ditch out of the East Rosebud at the same point. The canal was designed to carry two hundred second feet and ten miles of it were completed at a cost of \$100,000, but it has never been used. In June, 1902, they filed a water right for 250 second feet. This project secured an option on the old canal and water right for \$27,000.00. After the district was created, the Commission authorized the purchase and warrants have been issued against the district for the amount. This canal will be extended twenty miles and terminate at Thiel Creek. It will take fifty-five miles of laterals to serve the land. Some heavy side hill construction work was done along the old canal including several deep cuts and one tunnel. A short tunnel will have to be constructed along the new extension. The total net irrigable area is 12,510 acres. The total cost of the project is estimated at \$324,800 or \$25.98 per acre.

The net duty of water at the land is 1.50 acre feet per acre per season. Owing to the short season (about 84 days) the maximum demand is placed at fifty per cent for the month of July. The carrying capacity of the main canal to supply the maximum demand will have to be 200 second feet, which is the same as the original design of the old Weast Canal. The mean elevation of the project is 4,700 feet above sea level. The mean annual rainfall is 20.10 inches.

The original petition asking for the creation of the district was filed on March 25, 1920, with the clerk of the district court, Carbon County, and the secretary of the Montana Irrigation Commission. The gross area of the district as outlined in the petition includes 32,000 acres, 19,000 of which are signed up. There are 116 land owners and 64 have signed the petition.

The field work was done during June and July, 1920, and the report on the feasibility and cost of the project, together with the recommendations of the Montana Irrigation Commission, was filed with the clerk of the court on August 7, 1920. The date of the hearing of the petitioners and creating the district was August 10, 1920. A deposit of \$800 was requested to make the examination. The cost was \$535.39 and the balance of \$264.61 was returned. The report is neatly bound and indexed. The maps, pictures and subject matter compose twenty-three pages.

The project is one of the few localities in the state where alfalfa is grown quite successfully without irrigation showing what can be done by the application of water. About half of the area has been

occupied some fifteen or twenty years, but most of the lower part has been homesteaded within the last ten years. There are now 116 families representing a population of 382 persons. The district is greatly handicapped for raising crops which have to be marketed on account of being some twenty miles off the railroad. It is primarily a stock raising country so that fodder crops will prove to be the most profitable returns. The water supply is sufficient and the source is one of the best in the state, being fed by perpetual snows which melt late in the summer and keep the stream high through the irrigating season. The project was recommended as feasible.

PROJECT NO. 11.

Joliet and White Horse Bench Irrigation District, Carbon County.

Location, Near Joliet, Montana. Irrigable Area, 7,200 Acres. System, Storage to Supplement Direct Flow. Water Supply, Rock Creek. Elevation, 3,500 Feet. Cost, Not Determined. Report, Not Yet Completed.

This project is located in the northern part of Carbon County extending north from Joliet to the Yellowstone River. The land proposed to be irrigated is an area of more or less broken bench land lying between Rock Creek and Yellowstone River and sloping north and east. The soil ranges from clay loam to sandy loam with clay subsoil. Most of the land has been dry farmed for a few years, but with poor success. The land lies well for irrigation, and natural drainage is quite favorable.

The source of the water supply is from Rock Creek just below its junction with Red Lodge Creek. These streams are adjudicated and entirely used during low water stage, but it is planned to use direct flow during the high water, and store water in four mountain lakes for use during the low water stage. The lakes to be converted into reservoirs are situated near the head of middle fork of Rock Creek in the Bear-tooth mountains at an elevation of nearly 9,000 feet. They have a combined watershed of sixteen square miles with a probable yearly precipitation of thirty inches.

Black Canyon Lake is the largest of the proposed reservoirs. It has a present water area of 80 acres and a depth of over 200 feet, having been formed by a rock slide from the steep canyon walls. The dam rises 60 feet above the present water level, the porosity of the material preventing the water from rising higher. This furnishes a very unique case in reservoir construction, since no dam and no spillway need be built, the problem being one of tunneling the natural dam to draw off the water from the present lake when needed and then allow it to refill each year. By lowering the lake fifty feet, 3,500 acre feet of water will be available.

Keyser Lake is the smallest of the lakes. Here a dam thirty-five feet high will store 500 acre feet of water.

At Second Lake, a twenty-five foot dam will store 740 acre feet of water.

At Third Lake, a dam 40 feet high will store 2,100 acre feet of water.

These three dams are to be rock fill, having a double plank facing with asphaltic filling and backed with concrete. Water from these reservoirs is to be released during low water stage and allowed to run down Rock Creek to the mouth of Red Lodge Creek, where it is to be diverted by a canal and conducted ten miles to the top of White Horse bench.

The petitioners of the district first elected to come under the supervision of the district court, Carbon County and filed their petition accordingly. The court made an order on September 15, 1919, creating the district as petitioned for and three local commissioners were appointed. Mr. S. C. Kimball was appointed engineer and he made

surveys, drew up the plans and estimated the costs of construction to be \$350,000. These data were placed in the hands of the local district commissioners March 11, 1920. On April 2, 1920, the district presented a petition signed by 43 land owners, representing 4,384 acres of net irrigable area, asking to come under the supervision of the Montana Irrigation Commission. The approximate gross area of the district is 12,000 acres, out of which 7,200 acres net are irrigable. The amount of the deposit required to make the engineer's report and recommendations was \$700. The district forwarded a deposit of \$800. The field work was done during September, 1920. The engineer's report and recommendations of the Montana Irrigation Commission will be filed in the near future.

This project is very favorably located, near to railroads and markets and adjoining some of the best and highest priced irrigated land in the state. Much of the land is favorable for sugar beets, and the sugar factory at Billings furnishes a good market for this crop. If the water supply proves sufficient and the cost of construction is not excessive, this ought to make a very successful irrigation project, but on these two vital questions the status of the project must remain in doubt until the engineering report is completed.

PROJECT NO. 12.

Newlan Creek Irrigation District, Meagher County.

Location, 9 Miles Northwest of White Sulphur Springs. Gross Area, 1,290 Acres. System, Flood Water Storage and Gravity. Source Water Supply, Sheep and Newlan Creeks. Deposit Requested, \$50.00. Deposit Has Not Been Made.

This project is located in the heart of Meagher County in Smith River Valley, a tributary to the Missouri River. The town of White Sulphur Springs is nine miles southeast. The land to be irrigated is located in Township 10 North, Range 5 and 6 East. It is proposed to divert water out of Sheep Creek in Township 12 North, Range 7 East and carry it in by ditch and flume some five miles over the divide and spill into the headwaters of Newlan Creek. About eleven miles below, the water will be diverted by gravity out of Newlan Creek to irrigate land on each side. The construction of the diversion canal from Sheep Creek to Newlan Creek was started some twenty years ago and completed save one and one-quarter miles. It was designed to carry 500 miner's inches of water, but never has been used.

The normal flow of water in Newlan Creek is very small during the irrigation season and it is all appropriated by prior rights, so it is proposed to construct a dam along Newlan Creek to reservoir the spring flood water for use later in the season. The district has already posted its notices of water appropriation.

The petition asking for the creation of this district was filed on August 9, 1920, with the clerk of the district court, Meagher County and also the Secretary of the Montana Irrigation Commission. There are six land owners within the district representing a gross area of 1,290 acres, and all six have signed the petition. When the petition was filed there were no data of any kind in the way of maps or surveys accompanying it so it was assumed that no surveys had ever been made on the project, in which case it would be necessary for the state engineer to do such work before rendering his report to the Commission. Accordingly, a deposit of \$500 was requested as the estimated cost of making the examination. The petitioners objected to this amount as being excessive, so a personal interview was arranged, at which time they agreed to pay all transportation, living expenses, and furnish all survey helpers needed and pay for the same locally. This arrangement meets practically all the expense save a small office cost of making up the report. Project No. 13, which is in the same locality, can be worked at the same time, thus reducing the expenses of each. So the

first request for a deposit was withdrawn and amended to \$50 with the understanding that the local people would meet all other expenses in addition thereto while engaged in the field work. This deposit has not been made to date.

PROJECT NO. 13.

Wood's Gulch Irrigation District, Meagher County.

Location, 6 Miles West of White Sulphur Springs. Gross Area, 1,100 Acres. System, Storage and Gravity. Source of Water Supply, Wood's Gulch and Little Birch Creeks. Deposit Requested, \$50. Deposit Made, October 7, 1920, and Report Will Be Completed This Fall.

This project is located in the heart of Meagher County in Smith River Valley, a tributary to the Missouri River. The town of White Sulphur Springs is six miles east. The land to be irrigated is located in Township 9 North, Range 5 East. It is proposed to divert water by gravity out of Wood's Gulch and Little Birch Creeks in Section 32, Township 9 North, Range 5 East. The petition also calls for building storage reservoirs.

The petition asking for the creation of this district was filed on May 3, 1920, with the clerk of the district court, of Meagher County, and the secretary of the Montana Irrigation Commission. There are four land owners within the district representing a gross area of 1,100 acres. All four of the owners have signed the petition. When the petition was filed there were no data of any kind in the way of maps or surveys accompanying it, so it was assumed that no surveys had ever been made, in which case it would be necessary for the state engineer to do such work before rendering his report to the Commission. Accordingly, a deposit of \$300 was requested. Similar conditions exist



Potatoes Grown by Irrigation

as on the Newlan Creek District (See Project No. 12) so arrangements were made to look over this project at the same time as the Newlan Creek District and the local people will meet the field expenses in the same manner. Accordingly the requested deposit was reduced to \$50. The deposit was made with the Commission on October 7, 1920, and the field work and report will be completed this fall.

PROJECT NO. 14.

Meadow Farm Irrigation District, Gallatin County.

Location, 2 Miles Southwest of Three Forks. Elevation, 4,060 Feet Above Sea Level. Gross Area, 1,037 Acres. System, Gravity. Water Supply, Jefferson River. Deposit Requested, \$200.00. Deposit Not Made to Date.

This project is located near the northwest corner of Gallatin County two miles southwest of the town of Three Forks. The area is cut by the main lines of both the Chicago, Milwaukee and St. Paul and Northern Pacific railways along the valley of the Jefferson River. The land lies entirely within two sections under one ownership. It is proposed to divert water by gravity out of the Jefferson River in Section 18, Township 1 North, Range 1 East, and carry it to the land by a canal some three and one-half miles long.

The petition asking for the creation of this district was filed on July 24, 1920, with the clerk of the district court of Gallatin County, and also the secretary of the Montana Irrigation Commission. There are only two sections within the district, Section 3, Township 1 North, Range 1 East, and Section 35, Township 2 North, Range 1 East. The gross area of the district is 1,037 acres. A deposit of \$200 was requested to cover the expense of making the necessary surveys and report on the feasibility and cost of the project. Any balance remaining unexpended will be returned to the petitioners. To date, the deposit has not been made.

This project is a good example of the flexibility of the new law creating the Montana Irrigation Commission and the services the Commission can render the district. There is no limit on how large or how small a district may be or how many or how few owners there need be. In this case there is only one owner (a company) having 1,037 acres. They will have the report and approval (if the project proves feasible) of the Commission; the Commission will sell the bond issue and protect the owner against any faulty construction work. They will in this way have a chance to finance the project, which might otherwise have to remain undeveloped, and have a long term of years to pay off the cost in annual payments.

PROJECT NO. 15.

Upper Glendive-Fallon Irrigation District, Prairie and Dawson Counties.

Location, Yellowstone Valley. Elevation, 2,150 Feet. System, Pumping, Steam Power, Lignite Coal. Lifts, 400 Feet and 75 Feet Net. Water Supply, Yellowstone River. Irrigable Area, 4,210 Acres. Coal Consumption, 6,713 Short Tons. Peak Load, 527 H. P. Average Power Load, 331 H. P. Construction Cost, \$36.20 per Acre. Yearly Maintenance Cost, \$6.18 per Acre. District Created, November 10, 1920.

This project is located in both Prairie and Dawson counties along the Yellowstone River Valley in the eastern part of the state. Most of the district is in Dawson County. The land to be irrigated lies on the north side of the river extending from a point four miles below the town of Fallon down the river eleven miles. This project is a segregation of the original Glendive-Fallon District (See Project No. 5), being the "Upper Flat" irrigated by scheme No. 1.

It is proposed to divert water out of the Yellowstone River by pumping to two lifts 40 and 75 feet net, using steam power generated by local lignite coal. A pumping plant was built at the upper end of the project some eight or nine years ago and it is still in a good state of preservation. It has been used only three years to irrigate 150 acres of alfalfa under the forty foot lift.

The tract to be irrigated is a long narrow strip about two miles wide from the river to the foot of the hills which define the river valley. The surface is flat having a good drainage to the river. Several coulees and flood water streams cross through the area. There are no trees, stumps, brush or boulders on the project.

The field work was done during the first part of 1920 as a part of the larger project. Since the data gathered there included all the features of this project, no further field work was necessary. The petition asking for the creation of this district was filed with the clerk of the district court, Dawson County, and the secretary of the Montana Irrigation Commission on August 31, 1920. There are twenty-two land owners within the district, of which thirteen have signed the petition. The gross area within the district is 6,116.57 acres, out of which 5,032 acres are under the ditches. The net irrigable area is 4,210 acres, 1,660 acres being under the forty foot lift and 2,550 acres under the 75 foot lift.

The engineer's report and the recommendations of the Montana Irrigation Commission were filed October 19, 1920. The date set for hearing on the petition was November 9th. The deposit required for making the investigation and report was \$100. At least half of this amount will be refunded. The report is neatly bound and indexed and goes into every phase of the subject. The maps, pictures and subject matter include 36 pages.

The total estimated cost of the project is \$152,394.00 or \$36.20 per acre, and the annual cost of operation is estimated to be \$6.18 per acre. The capacity needed to supply the peak load is 133 H. P. for the 40 foot lift and 394 H. P. for the 75 foot lift, making a total of 527 H. P. The average power used per season is 84 H. P. for the 40 foot lift and 247 H. P. for the 75 foot lift, making a total of 331 H. P. The estimated amount of coal consumed per season is 6,713 short tons. It is estimated that 160 acres of coal land will operate the plant 159 years.

The length of the irrigation season is 130 days. The duty of water is two acre feet at the pumps and the maximum demand of 0.76 acre feet comes during the month of July. From the actual results of operation of the steam plants at Glendive and Fairview, using the same grade of coal as this project proposes to use, it was found that a conservative estimate of 13 pounds of coal per H. P. H. would be needed.

The water supply is sufficient; the soil and climate are suitable for raising hay, grain, alfalfa, flax and sugar beets. The main line of the N. P. railway is just across the river and a wagon bridge crosses the river at the upper end of the project. The C. M. & St. P. railway is within five miles of the upper end of the project. The land lies well for irrigation; the coal supply is plentiful and located at the pumping plant. In fact, all the conditions are ideal save an economical method of diverting water onto the land. However, this project should be a success under the right kind of management.

CONTEMPLATED PROJECTS.

Besides the fifteen projects which have come under the jurisdiction of the Commission, many requests have been made for the inspection of projects contemplating the formation of districts. In such cases, the Commission has requested the interested people to guarantee the expenses (not including salaries) of the engineers from Helena and return. The following, which total approximately 650,000 acres come under this head.

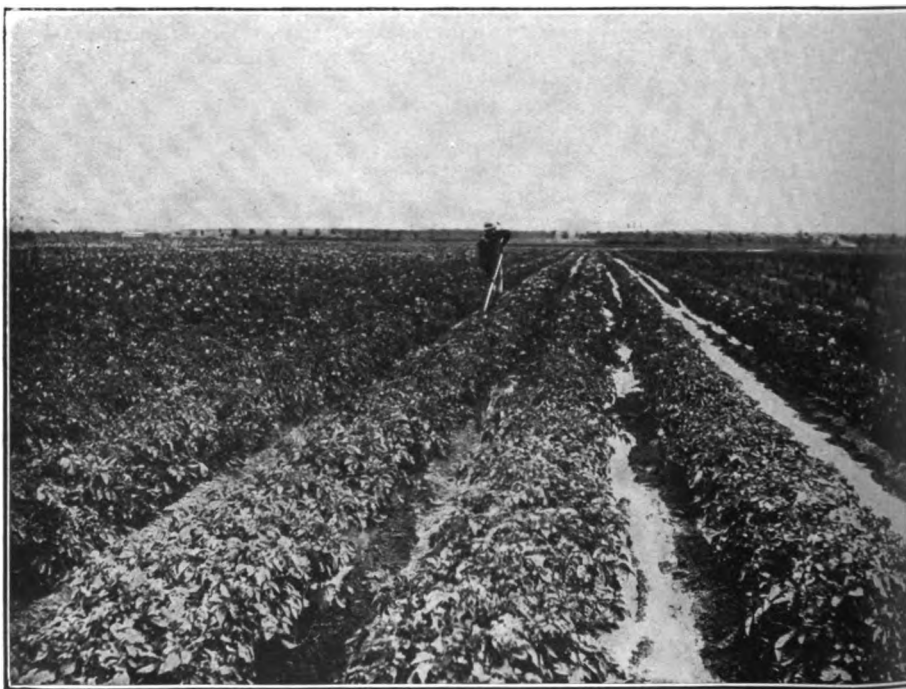
DEARBORN PROJECT.

This proposed project is located in both Lewis and Clark and Cascade counties. They propose diverting water out of the Dearborn River, a tributary of the Missouri River in the eastern part of Lewis and Clark County to irrigate some 30,000 acres on the bench in Cascade County, located between the Dearborn and Sun Rivers on the west side of the Missouri River. This project was initiated several years ago as a Carey Act Project. The contracts were let and considerable construction done, but owing to disagreements between the state and the contractor, the project was cancelled and nothing done with it since.

It is now being revived and petitioners, asking for the creation of an irrigation district, are being signed up. The Commission has had many requests from the promoters on questions concerning the project. It is probable this district will call upon the Commission in the near future for an investigation and report on its feasibility and cost.

BRINKMAN AND LONESOME LAKE.

These two proposed projects are located along the Marias River in Chouteau and Hill counties. It is proposed to divert water out of the Marias River and also build storage works for the conservation of flood waters. The two projects propose the irrigation of approximately 350,000 acres. The interested people have requested the services of one of our engineers and have guaranteed his expenses from Helena and return. These two districts propose organizing under the jurisdiction of the Montana Irrigation Commission this coming year.



A Well Irrigated Farm

SOUTH BENCH.

This proposed project is located in the northeastern corner of Madison County and western part of Gallatin County. The land to be irrigated is located on two crescent shaped benches south of the town of Three Forks. The upper bench is some 100 feet or more higher than the lower bench. There are approximately 25,000 acres on each bench. Two sources of water supply and four schemes of irrigation are under consideration.

Scheme No. 1 proposes diverting water by gravity out of the Madison River near the mouth of Hot Springs Creek and carry it to the lower bench only. This would require several miles of expensive side hill ditch and flume.

Scheme No. 2 proposes building a dam and reservoir on Norwegian Creek near its mouth and divert the waters of Willow Creek into the reservoir. Water would be diverted by gravity from the reservoir to the lower bench. About two miles of flume would be needed along Willow Creek Canyon. If the water supply proves insufficient, the flow of South Boulder Creek could easily be diverted over into Willow Creek.

Scheme No. 3 proposes diverting water out of the Madison River at a point some twelve miles above the town of Ennis and carry it by gravity ditch, flumes and tunnel to the upper bench to irrigate the entire thousand acres. This scheme involves several difficult and costly engineering problems.

Scheme No. 4 proposes diverting water out of the Madison River near the mouth of Hot Springs Creek and carrying it by gravity down to a favorable point for the installation of a hydro power plant. The flow conveyed by the canal would develop power to lift enough water to the upper bench to irrigate the entire 50,000 acres. This system, besides bringing up many engineering questions, would involve the additional expense of maintenance.

The promoters of this district asked the Commission's engineers to examine the project and guaranteed the expense from Helena and return. The trip was made during the fore part of July. The purpose was to help the local men in deciding upon some scheme that might seem the most feasible before expending a needless amount of money on engineering investigations. The Commission recommended that preliminary work be done on Scheme No. 3 for irrigating the entire 50,000 acres and if the results of surveys show this to be too costly or impractical then Scheme No. 2 be developed for irrigating the 25,000 acres on the lower bench.

The soil is a good sandy loam, rich in lime, and the topography is well adapted to irrigation. Preliminary engineering work is now being done and it is expected the petition asking for the creation of the district will be filed with the Commission next summer.

SILVER FLAT PROJECT.

This proposed project is located in Lewis and Clark County northwest of Helena on what is locally known as "Silver Flat". There are approximately eight to ten thousand acres that can be irrigated. It is proposed to divert water out of Silver Creek, Little Prickly Pear Creek and Canyon Creek. Several sites were investigated with a view of developing reservoirs for the storage of flood waters to augment the normal flow during the irrigating season.

Upon the request of some of the interested people, the Commission sent one of its engineers over the ground to confer with them preparatory to circulating a petition asking for the creation of an irrigation district. The Commission expects to have this project filed and ready to be investigated and reported upon early next year.

FLINT CREEK.

This proposed project is located in Granite County in the Flint Creek Valley. It is proposed to irrigate some 20,000 to 30,000 acres of bench land above the present irrigated areas near the towns of Hall and New Chicago, and also a possible area on the west side of the valley near Phillipsburg. It is proposed to divert water out of both the East Fork and Middle Fork of Rock Creek and carry it by gravity over the divide into the Flint Creek Valley and empty it into Willow Creek. From there diversions will be made onto the land. Several reservoir sites along Rock Creek and Willow Creek and tributaries of Flint Creek were inspected with a view of storing flood waters to augment the normal flow during the irrigating season.

Upon the request of some of the local people who guaranteed the expenses of the engineer from Helena and return, an inspection was made of the possibilities during September. The project will involve some engineering difficulties and doubtless will prove to be a costly undertaking. The canal system will necessarily be long and the reservoirs will all have a nominal capacity. The only available information on the possibilities was obtained from the U. S. Geological Survey plats and a reconnaissance survey will be necessary in order to arrive at any definite conclusions. It is likely that petitions will be filed with the Commission this coming year asking for an engineering investigation and report on the proposed undertaking.

CROW CREEK IRRIGATION DISTRICT.

This proposed project is located in Broadwater County adjoining the town of Radersburg. The irrigable area is 50,000 acres estimated to cost \$42 per acre. It is proposed to divert water out of the Jefferson River near Twin Bridges and carry it down to the land by canal, flumes and tunnels. An additional water supply is to be obtained by constructing a storage reservoir on Crow Creek some four miles northwest of Radersburg. The district has been in process of organization some time and most of the preliminary engineering work is completed. They have applied to the Commission for an investigation of the feasibility and cost of the project. A deposit of \$1,500 was requested and \$1,000 has been deposited with the promise of the balance shortly. It is expected the Commission will make its investigation this winter and render its report before the coming spring. Some of the engineering features developed by the preliminary work are a rock fill dam on Crow Creek 200 feet high and crest of 600 feet; the reservoir capacity is 16,000 acre feet. The canal from Jefferson River is 80 miles long; two miles of tunnels; three or four miles of flumes; nine or ten miles of concrete canal lining; 1,800 feet of syphon across the Jefferson canyon; and drainage works.

JUDITH BASIN.

This proposed project is located in the newly created county of Judith Basin. The land to be irrigated lies on both sides of the Judith River immediately below the canyon and adjacent to the towns of Hobson and Moccasin.

There are about 60,000 acres that can be irrigated on each bench, making 120,000 acres under irrigation when completed. It is proposed to build several storage reservoirs on the Judith River for the conservation of flood waters. Last year the local people subscribed \$3,000 to pay the cost of having the U. S. R. S. make a survey and report on the project. The report is very thorough and deals with every phase of the subject. During July, the Commission, upon request of the promoters, made a hurried investigation over the project with the idea of assisting in organizing the district. It is expected that the petitions will be filed early next summer.

CAREY ACT PROJECTS

A considerable acreage in Montana has been irrigated under the provisions of the "Carey Act", passed by Congress in 1894. This law granted to the state 1,000,000 acres of Government land on condition that the state would reclaim the same. The State Arid Land Grant Commission was organized and attempted to handle the reclamation directly, but met with little success. After ten years of operation, and the expenditure of considerable money, with the accomplishment of no actual irrigation the Commission was reorganized into the present Carey Land Act Board, which assumed control in 1905, and since that time has had supervision of the Carey Act projects, but has not attempted to do the work directly.

Under the present system, the Carey Land Act Board contracts with private companies for the construction of the irrigation systems, and the Department of the Interior segregates the lands for the exclusive use of the construction company. When lands are reclaimed only such settlers are allowed to file as have made contracts with the Company to furnish water for irrigation.

Under this system the Carey Land Act Board has been fairly successful in securing development of several large projects. In all 12 projects have been initiated, but six of these were canceled before much money was spent on construction. In one case, however, that of the Dearborn project, \$200,000 was spent in construction and the project finally dropped. Six of the Carey Act projects are still being developed under supervision of the Board, covering a total of 186,000 acres of irrigable land and having an estimated cost of over \$7,000,000. .

Since the success of the Carey Act projects depends largely upon securing a segregation of Government lands, and since no such tracts are now open for segregation, it is not likely that additional Carey Act projects will be initiated, but the present projects will require several years to complete and will be an important factor in the irrigation development of the state.

A brief outline of the six Carey Act projects now under supervision of the Carey Land Act Board is given below. Full details on these projects are included in the official reports of the Board published biennially.

VALIER PROJECT.

This is the largest of the Carey Act projects, including a gross area of 165,000 acres, of which 80,000 acres are actually irrigable from the available water supply.

This project is located in Pondera County at an elevation of 3,600 feet. The soil is a deep fertile loam, and the land lies well for irrigation. Water supply is furnished from Birch and Dupuyer creeks, using the direct flow supplemented by storage in two large reservoirs. The Birch creek reservoir with a rock-fill dam 157 feet high stores 30,000 acre feet of water, and the Lake Frances dam near Valier with an earth dam 40 feet high stores 112,000 acre feet.

The canal system consists of 43 miles of main canals, 134 miles of laterals, and 192 miles of distributing ditches. The main structures are of substantial concrete construction, and a wood stave siphon has been installed at Big Flat Coulee, 7 feet in diameter and 2,900 feet long.

The project has been in operation for several years with a constantly increasing acreage under crops, and the yields have been very satisfactory. This is classed as one of the successful projects in the state, and will probably continue to give very satisfactory returns. The total cost of the project has been a little over \$4,000,000, or an average of \$50 per acre for the irrigable lands. During the present year 75,000 acres were irrigated.

BILLINGS BENCH PROJECT.

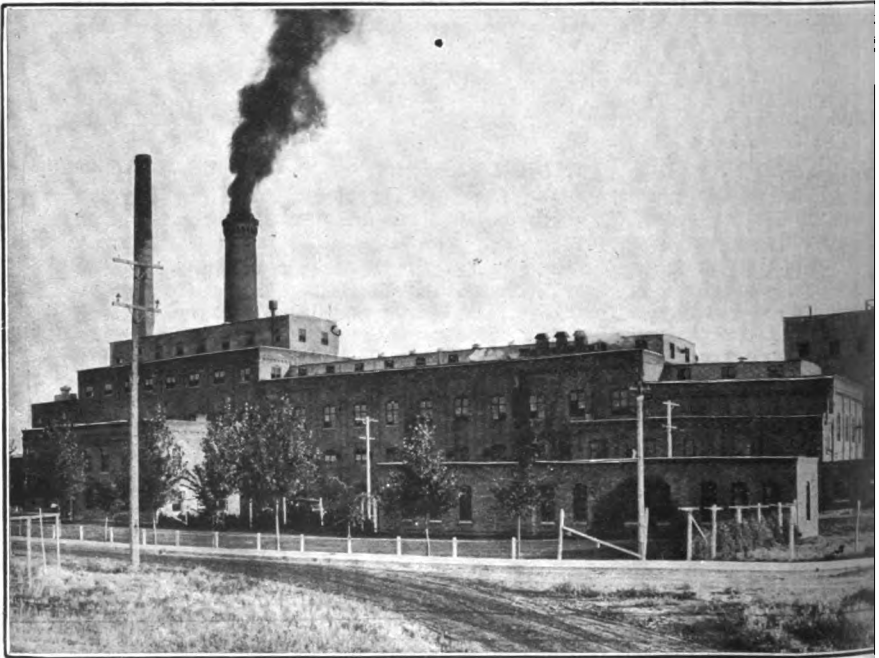
This project is located in Yellowstone County, extending north and east from the city of Billings. The total acreage included is 34,000 acres of which 24,000 will be actually irrigated. During the present year, over 17,000 are under irrigation.

The project has been built by the Billings Land and Irrigation Company and is practically completed. Water is diverted from the Yellowstone river and carried to the land through 60 miles of main canal and 100 miles of laterals. The diversion is 20 miles above the city of Billings. Total cost of construction is \$500,000. The main canal includes 2,000 feet of flume, 2,800 feet of siphon, and 1,850 feet of tunnel. The average elevation of the lands irrigated is 3,000 feet above sea level, and the land is mainly a rich clay soil, and produces heavy crops. A good local market is furnished for most products, and a branch line railroad from Billings through the project furnishes ample transportation. The project is a success.

BIG TIMBER PROJECT.

This was one of the first Carey Act projects undertaken, and has had a varied career. The present contracting company is Glass-Lindsay Land Company of Big Timber. The lands lie northward from Big Timber in Sweet Grass County, having an average elevation of 4,200 feet, and being composed of rolling bench lands, cut by many coulees and washes.

Of the gross area of 32,000 acres, 17,000 acres are actually irrigable. Although construction was nearly completed as early as 1908, the total area actually irrigated to date is only 3,700 acres.



Sugar Beet Factory at Billings

The chief difficulty with this project has been in securing proper settlers on the land and in properly financing the project and the settlers.

The water supply is ample and the soil fertile, and there is no reason why this project should not eventually become one of the best. The water is furnished from Big Timber and Sweet Grass Creeks, supplemented by storage in two large reservoirs. The upper reservoir has a present capacity of 6,000 acre feet, and is to be ultimately increased to 9,000 acre feet. The lower reservoir is now built to hold 12,000 acre feet and is capable of extension up to 23,000 acre feet.

The canals are practically completed, and most of the land is available for settlement and irrigation. The main canals total 34 miles in length.

The estimated duty of water is $1\frac{1}{2}$ acre feet per acre delivered at the land.

The total cost of construction has been \$1,000,000 making an average unit cost of \$59 per acre.

TETON PROJECT.

This project is located in Teton County, with some of the segregated land extending into Pondera County near the town of Brady. Water supply is from Teton river and Blackleaf and Muddy creeks, supplemented by storage in the Bynum reservoir.

The contracting company is the Teton Co-Operative Reservoir Company of Helena. The total acreage included within the project is 34,166 acres, of which 30,000 are actually irrigable. Most of this land is covered by Carey Act segregation, approval of which is still pending. There has been much delay in the development of this project, and it now seems likely that approval may not be secured. An irrigation district has already been organized to take over this whole project. The total estimated cost of construction under the original plan was \$950,000. Already \$400,000 have been spent in the construction of the Bynum dam and a canal to supply same.

Five thousand acres of private lands near Brady have been irrigated under this system for several years, and with fair success. The Bynum reservoir will have a capacity of 70,000 acre feet. Soil and climatic conditions are favorable on this project, and if ever developed either under the Carey Act or under the proposed irrigation district, this should eventually become one of the successful projects.

FLATWILLOW PROJECT.

This project is located in Fergus County, and proposes to irrigate 15,000 acres of land by diversion from Flatwillow Creek, supplemented by storage in a reservoir of 17,000 acre feet capacity.

The Fergus County Land and Irrigation Company of Lewistown, which is handling this project, has had difficulty in financing development, but has recently been doing some construction, and expects to continue the project to completion. Eighty-two thousand dollars have already been spent and the main canal is partly completed. The total estimated cost of the project is \$350,000, or an average of \$23 per acre for the irrigable lands.

LITTLE MISSOURI PROJECT.

This project is located in the extreme southeast corner of the state, along the west side of the Little Missouri river, from which stream it is to derive its water supply by direct flow, supplemented by storage in a reservoir of 20,000 acre feet capacity. The total area included in the project is 26,000 acres, of which only 20,000 are actually irrigable.

The Little Missouri Land and Irrigation Company of Butte is the contracting firm. The segregation has been approved and the company is now endeavoring to finance construction and complete the project. To date only \$32,000 have been spent and 10 miles of canal have been constructed. No land has yet been irrigated from the project. The total estimated cost of construction is \$250,000. The average altitude of the land is 3,000 feet. The soil is fertile and climatic conditions favorable for growth of ordinary farm crops, but lack of transportation is one of the chief difficulties, the nearest railroad being 45 miles from the project. Albion and Erickson are the principal towns within the project.

SUMMARY CAREY ACT PROJECTS.

A review of the six active projects now under the supervision of the Carey Act Board shows the gross acreage, the net irrigable acreage, cost of construction, and the acreage irrigated during the present year as follows:

Project.	Gross Acreage.	Net Acreage.	Irrigated.	Cost.
Valley	165,000	80,000	75,000	\$4,060,000
Billings	34,000	24,000	17,000	500,000
Big Timber	32,000	17,000	3,700	1,000,000
Teton	34,000	30,000	5,000	950,000
Flatwillow	26,000	15,000		350,000
Little Missouri	26,000	20,000		250,000
Totals	317,000	186,000	100,700	\$7,110,000

UNITED STATES RECLAMATION PROJECTS

A large acreage in Montana has been reclaimed under the provisions of the Reclamation Act passed by Congress in 1902. This law provides that funds from the sale of public lands be devoted to the reclamation of arid lands in the several western states, and under this law Montana has a larger number of projects than any other western state.

Four projects under direct charge of the United States Reclamation Service and three projects constructed by the Reclamation Service in conjunction with the United States Indian Department constitute Montana's quota under this act. On these seven projects over twenty million dollars have already been spent; and the total estimated cost amounts to nearly thirty-nine million dollars. The total acreage to be irrigated under these projects is 864,000 acres. To date, construction is completed for 344,000 and of this amount 145,000 acres are actually irrigated. For lack of sufficient funds, construction of these projects has been very much delayed and the delay has been a source of disappointment and heavy loss to the early settlers under the projects. Default in the annual payments on most of the projects caused the passage in 1914 of the Reclamation Extension Act, allowing a twenty year period in which to repay construction costs to the government. This further limited the available funds and for the past several years the projects have been greatly handicapped in carrying out their plans for reclamation. Some of the projects which were completed at an earlier date have met with considerable success and all will in time be fairly successful if the construction can be completed without further delay.

Under some projects, completed units have recently organized as irrigation districts in order to gain control of the administration of the project, and this method promises very successful operation and assures a possibility of financing the settlers through Federal loans which would not be possible while the government held prior lien on the lands. The following table shows the acreage and cost of the various projects:

UNITED STATES RECLAMATION PROJECTS.

Project	Acreage Irrigable	Acreage for Which Works Completed	Acreage Now Irrigated	Estimated Cost of Project
Huntley	33,000	31,000	20,000	\$ 1,912,000
Lower Yellowstone	60,000	42,000	22,000	3,154,000
Milk River	192,000	68,000	46,000	9,427,000
Sun River	175,000	40,000	12,000	8,443,000
Ft. Peck (Indian)	152,000	17,000	1,000	5,630,000
Blackfeet (Indian)	118,000	48,000	10,000	3,600,000
Flathead (Indian)	134,000	98,000	34,000	6,620,000
Total	864,000	344,000	145,000	\$38,786,000

HUNTLEY PROJECT.

This was the first reclamation project in the United States to be started and also the first to be opened for settlement, and is classed as one of the successful projects of the Reclamation Service. It is located in Yellowstone county not far from the city of Billings at an average elevation of three thousand feet above sea level. The land lies along the south side of Yellowstone River and is mostly a clay silt of considerable fertility. Water is diverted from Yellowstone River and distributed through a very substantially built system of canals, covering a total of 33,000 acres irrigable.

The system has been completed for nearly all of the lands since 1907 and has been successfully farmed since that date. Alfalfa, sugar beets and grains are the chief products. Excellent market and transportation facilities are furnished and returns from the land are very satisfactory. Seepage and alkali troubles have, however, developed and the Reclamation Service found it necessary to install a complete drainage system over the greater part of the area. Twenty-two thousand acres have been successfully drained and still further extension of the system is planned. The average farm unit is about fifty acres and intensive cultivation is practiced. Twenty thousand acres are actually irrigated under the project, during the present year. The cost of the project to date amounts to \$1,420,000, while the total estimated cost of the project is \$1,912,000.

LOWER YELLOWSTONE PROJECT.

This project lies along the west bank of the Yellowstone River in Richland and Dawson counties in the extreme eastern end of the state and a small part of the project also extends into North Dakota. There are at present 600 farm units on the project and eight towns are located within the area, the largest being Sidney with a population of 1,400. The Great Northern railway runs the full length of the project, furnishing ample transportation. The total irrigable area is 60,000 acres. Works are already completed for 42,000 acres and of this amount 22,000 are now actually irrigated.

The average elevation of the land is 1900 feet above sea level. The temperature ranges from 46 below to 110 above. The annual precipitation is 16 inches and in normal years fair crops are grown without irrigation. This feature has delayed the development of the project since many of the settlers are not thoroughly converted to the necessity of irrigation. The estimated duty of water under this project is one and one-half acre feet per acre delivered at the land. The total cost to date is \$2,894,000 and the estimated cost for the complete project will be \$3,154,000.

MILK RIVER PROJECT.

This project embraces a total acreage of 192,000 irrigable acres, extending for 160 miles along the valley of the Milk River in Blaine, Phillips and Valley counties. The direct flow of Milk River supplemented by storage in St. Marys Lake furnishes the water supply for this project. At St. Marys Lake 218,000 acre feet are to be stored and

later diverted into the head of Milk River by a canal 29 miles long. Diversion dams on Milk River at Dodson and Vandalla carry the water onto the lands along the river. A secondary storage reservoir is provided at Nelson Lake near Malta with a capacity of 142,000 acre feet. Work was begun on this project in 1902 and has been carried on continuously since that time and 68,000 acres are now served by completed works. Of this amount, 46,000 acres are actually irrigated. The project to date has cost six million dollars and the completed plans call for an expenditure of \$9,427,000.

The Great Northern railroad runs the full length of the project, furnishing ample transportation for all crops. The principal towns within the project are Chinook, Harlem, Dodson, Malta, Saco, Hinsdale and Glasgow. The average elevation of the irrigable land is 2,200 feet above sea level. The mean annual precipitation is 14 inches. The soils under this project vary from light sandy loams to heavy clay and gumbo. Wheat and alfalfa are the principal crops and the yields are quite heavy. Ninety-five thousand acres are to be irrigated under canals diverting from the river at Dodson, 28,000 acres by diversion near Vandalla and 97,000 acres by diversion near Chinook. In this latter acreage are included 28,000 acres served by company ditches constructed independently of the Reclamation Service, but having contracts with the service for use of water stored in St. Marys reservoir. This area of 28,000 acres is not included in the figures of the project given above, but is reported under district organizations in the Blaine County report.

SUN RIVER PROJECT.

This project contemplates the irrigation of 175,000 acres in Choteau, Cascade and Lewis and Clark counties by diversion from Sun River and its tributaries. The natural flow of these streams is to be supplemented by storage in three reservoirs, Warm Springs reservoir to have a capacity of 269,000 acre feet, Willow Creek reservoir with 86,000 acre feet and Piskhun reservoir with a capacity of 45,700 acre feet.

The Fort Shaw unit of this project, with an area of 16,000 acres, was completed about ten years ago and has been in successful operation since that date. Under this unit, 10,000 acres are now irrigated. Works are now completed to serve a total of 40,000 acres and of this amount 12,000 are now actually irrigated. The cost to date has been \$3,736,000 and the estimated cost of the entire project is \$8,443,000.

The lands under this project include both bench and valley lands and are quite productive. In the valley lands, however, necessity for drainage has arisen and the plans include a drainage system for part of the acreage. The total precipitation in this section is only eleven inches and irrigation is necessary for the production of crops. Two railroads through the project furnish ample transportation. Fairfield, Ft. Shaw, Sun River and Simms are the principal towns.

FORT PECK PROJECT.

This project is being constructed by the Reclamation Service in co-operation with the United States Indian Department. The total irrigable acreage is 152,000 acres. Water supply is derived from Poplar River and Porcupine and Big Muddy creeks. Only a small part of this project is thus far completed and a thousand acres are now irrigated. The total cost to date has been \$740,000 and the complete project calls for the expenditure of \$5,630,00. Most of the lands to be reclaimed are Indian allotments under the former Fort Peck Indian Reservation. No lands are now open to entry.

BLACKFEET (INDIAN) PROJECT.

This project is located in Glacier County, mostly included within the Blackfeet Indian Reservation. The total irrigable acreage is 118,000 acres, of which 11,000 acres lie outside of the reservation. Several separate units are included within this project, diverting water from Cut Bank and Two Medicine rivers and from Birch and Badger creeks. Works are already completed for the irrigation of 48,000 acres, but of this amount only 10,000 are now actually irrigated. The lands now irrigated are mostly Indian allotments, although some of them are farmed by white tenants. The total expenditure to date is \$1,080,000 and the total estimated cost of the project is \$3,600,000. Browning and Cut Bank are the principal towns included within the area served by this project. The lands are mostly rolling and more or less broken bench lands of considerable fertility and with favorable climatic conditions for the production of ordinary farm crops. The mean annual precipitation is 15 inches and the average elevation above sea level is 4,000 feet.

FLATHEAD (INDIAN) PROJECT.

This project is being constructed by the Reclamation Service in conjunction with the Indian Department to serve 134,000 acres of land within the former Flathead Reservation. In Missoula and Flathead Counties, works are now completed to cover 98,000 acres and of this amount 34,000 acres are actually being irrigated. The average elevation above sea level is 3,000 feet and the mean annual precipitation is 18 inches. Seven hundred farms are included within the project. Hay, grain and potatoes are the principal crops, although some fruit and vegetables are raised. The total expenditure to date is a little over four million dollars, while the estimated cost of the complete project is \$6,620,000. Polson, Ronan and St. Ignatius are the principal towns within the area.

COUNTY IRRIGATION SURVEYS.

The following pages contain a brief summary of the irrigation being done and the possibilities of future development in each county of the state.

BEAVERHEAD COUNTY.

Beaverhead County is in southwestern Montana bordering Idaho on the west and south. The main range of the Rockies actually defines this boundary line. Its total area of 5,632 square miles is generally mountainous and rough with several large wide valleys along the streams. Dillon is the most important town and is the seat of the County government. It has a population of 2,700 people. The county forms the headwater drainage for the Jefferson River. The Big Hole, Wise River, Red Rock River and Beaverhead River are the most important streams. The soil in the valleys is a clay loam and on the benches a sandy loam. The average elevation of the agricultural areas is 5,100 feet above sea level; the mean annual rainfall is 17.5 inches and the growing season 101 days. Stock raising ranks as the chief industry. Farming, mining and lumbering are also important industries. The chief crops are hay, wheat and oats. The chief markets are Butte, Salt Lake City and Chicago. The Oregon Short Line traverses the county from north to south. The Gilmore and Pittsburgh runs west from Armstead in the southern part of the county. There is also a narrow gauge line in the northern part from Divide to Elkhorn. Good county roads cover the entire county.

The county assessor's records show that the assessed valuation of irrigated land totals \$6,627,713, that of non-irrigated totals \$852,616 and that of grazing totals \$3,201,436.

Irrigation has been practiced since the early days. The first settlers in the late sixties settled along the bottoms and constructed diversion canals from the streams. Later, partnerships and groups organized and built higher and longer canals until at present the summer flow of all the streams is entirely appropriated and a total of 380,000 acres in all parts of the county is irrigated. The following shows a summary of the present development. After the locations are given in round numbers the acres irrigated: Big Hole Basin, 150,000 acres; Beaverhead River, 70,000 acres; Blacktail Deer Creek, 10,000 acres; Birch Creek, 6,000 acres; Centennial Valley, 30,000 acres; Grasshopper, 15,000 acres; Horse Prairie, 60,000 acres; Medicine Lodge, 6,000 acres; Rattlesnake Creek, 4,000 acres; Sage Creek, 6,000 acres; Sheep Creek, 10,000 acres; Trapper Creek, 3,000 acres; Willow and Rock creeks, 6,000 acres and Wise River Valley, 5,000 acres.

Gauging stations are established on the Beaverhead River at Baratts Station and at Dillon, on Big Hole River at Dewey and Melrose, on Red Rock River at Lima, Monida and Red Rock. Gauging stations should be placed on both Grasshopper and Blacktail creeks. Most of the streams in the county have been adjudicated.

There is only one irrigation district organized in the county under the district court. This one, known as the Big Hole Irrigation District, took over the holdings of the Trail Creek Water company. It is located in the Big Hole Valley west of Wisdom. The source is Trail Creek, the water being conveyed by gravity through canals and flumes to the land. One hundred and forty thousand dollars' worth of bonds were sold and all but \$10,000 was paid for the Trail Creek Water company's holdings. The \$10,000 was used for repairs and extensions. Five thousand two hundred acres have been irrigated with this system. Considerable trouble with the canals and flumes has made a high maintenance cost, although the project is considered successful.

The East Bench Irrigation District was organized in 1920 to reclaim 13,900 acres of bench land east of Dillon. This is being handled by the Montana Irrigation Commission and is treated in another section of this report.

On the Red Rock River twelve miles above Lima a reservoir has been developed by constructing a fifty foot earth dam. Its capacity is 60,000 acre feet. It was built in connection with a Carey project of 20,000 acres near Lima. The Carey project failed to materialize and the Red Rock Reservoir and Irrigation Company was organized to take it over for \$250,000, of which \$50,000 has actually been paid. The corporation is open, a share corresponding to an acre foot of water, it being the intention to increase the reservoir's capacity to 100,000 acre feet. In connection with this the Red Rock Lake Company is a corporation now constructing a canal from the river just below the dam to irrigate 6,000 acres. Water will be purchased from the reservoir company. This project is expected to operate in 1921.

There are several thousand acres of irrigable land in the county. Near Lima are about 15,000 acres of private and state land. East of Dillon above the East Bench Irrigation District project there are 5,000 acres. Near Apex on the bench between the Big Hole and the Beaverhead there are 5,000 acres. Scattered variously through the county are an additional 5,000 acres.

There are several reservoir sites available for storage purposes, adjacent to good supply sources. Blacktail Deer Creek has a site possible of storing 25,000 acre feet. Alturus Creek, a branch of Rattlesnake, has a site that would store 3,000 acre feet. Eight thousand acre feet could be stored in a site on the North Fork of Cottonwood



Good Roads and Plenty of Water Mean Wealth to the Farmer

Creek. On Cat Creek, a tributary of Rattlesnake, 16,000 acre feet could be stored. Most of this water would be used to augment the flow that is used lower down at present, but would be an advantage to the water users on these streams.

In all, about 45,000 acres are irrigable in the county. At an average increase in valuation per acre of \$30, the county would realize a gain of a million dollars in valuation.

BIG HORN COUNTY.

Big Horn County is in the southern part of the state adjoining the Wyoming line. It has an area of 5,100 square miles and a population of 7,000 of which 1,400 are in Hardin, the county seat and principal town. The greater part of the county is included within the Crow Indian Reservation which, however, is soon to be opened to settlement.

The topography varies from broad level valleys to steep rocky mountains of considerable height. The altitude at Hardin is 3,000, while the average elevation of the farming lands is about 3,300 feet. The Big Horn river and its tributaries drain most of the county and furnish practically all the water supply for irrigation.

The mean annual rainfall at Hardin is 15 inches and the average growing season between frosts is 122 days. About 100,000 acres are now irrigated and a quarter of a million acres are dry farmed. Small grains, alfalfa, corn, potatoes and sugar beets are the leading crops. Ample markets and transportation are provided.

Average land values are \$10 per acre for grazing land, \$30 for dry farm lands and \$100 per acre for irrigated land. The assessed valuation of the county is \$22,000,000.

The irrigated lands of the county are mostly along the valleys of the Big Horn and Little Big Horn rivers. These streams have more than ample water supply. Some of the tributaries also furnish irrigation for a few hundred acres. None of the streams are adjudicated.

The U. S. Indian Service is constructing a system to serve Indian lands to the amount of 74,000 acres. Half of this acreage was actually irrigated in 1920. The system consists of several separate canals, the largest of which is the Big Horn canal, irrigating 33,000 acres on the east side of the river near St. Xavier. The Agency Ditch near Crow Agency on the Little Big Horn covers 7,000 acres. Ditches from Prior Creek cover 5,500 acres.

Outside of the reservation the largest ditch is the Two Leggin canal which irrigates 20,00 acres near Hardin. This ditch is 30 miles long and was built in 1909, at a cost of \$13 per acre. Annual maintenance cost is \$1 per acre, and crop yields are very heavy. At the lower end of the land, seepage troubles are developing.

The Big Horn Low Line Ditch below Hardin waters 8,000 acres. Much of this land now requires drainage.

Plans are under way for the formation of four drainage districts to reclaim irrigated lands below Hardin. These are excellent lands and when properly drained will produce heavy crops.

There is ample water supply for a large increase in the irrigated acreage of this county and the opening of the Indian Reservation will probably give a new impetus to such development.

The Big Horn Canyon Irrigation and Power Co. was incorporated in 1912 to develop a mammoth irrigation and power project in this county. Complete surveys have been made but the Company has not yet been able to finance construction. The project contemplates the construction of a dam in Big Horn Canyon forty miles above Hardin,

the development of 217,000 horsepower electric energy, the building of sixty-eight miles of electric railway running full length of the Big Horn valley and connecting with the N. P. Ry. at Custer and the Burlington Ry. at Hardin, and the irrigation of 100,000 acres of land in the Big Horn valley. Ed Lawler of Hardin is Secretary of the Company.

BLAINE COUNTY.

Blaine County lies in northern Montana adjoining the Canadian border, and is bounded east by Phillips, south by Fergus, and west by Hill County. It has a total area of 4,200 square miles. Chinook, with a population of 1,200, is the county seat. Harlem, with 700 people is the only other town of importance. The total population of the county is about 9,000.

The county is composed mostly of rolling prairies and bench lands cut by occasional coulees. Milk river runs from west to east across the middle of the county. The only hills of any importance are in the southwest corner of the county. The Fort Belknap Indian Reservation occupies the southeast quarter of the county. The prevailing soil type is a clay loam though there are also stretches of gumbo along the river valley and some areas of sandy loam on the benches. Most of the soils are quite fertile when properly drained, but subject to considerable alkalification when water-logged.

The principal crops are dry land wheat and irrigated alfalfa. The grain and live stock are shipped mostly by rail to eastern markets, the main line of the Great Northern railway furnishing good transportation facilities for most of the county.

The climate is typical of Northern Montana, with hot summers and very cold winters. Wind is excessive in spring and early summer. Hail does some damage at times. The average growing season, between killing frosts, is 120 days.

Assessed land valuations in this county are \$30 to \$60 for irrigated land, \$12 to \$14 for non-irrigated tillable land, and from \$8 to \$10 for grazing land. According to the assessment rolls there are 24,000 acres of irrigated land, 440,000 acres of non-irrigated tillable land, and 713,000 acres of grazing land. The total assessed land value of the county is \$18,000,000, while the grand total of all property in the county is \$28,000,000.

Irrigation has been practiced in this county for many years, and with good success, the principal areas being along Milk River near Chinook. Milk River is the only stream in the county flowing the year round and is, therefore, practically the only source of water supply for irrigation, both present and future. A few acres are irrigated by storage on the intermittent streams, and a further extension of irrigation by this means is possible.

Along Milk River, several important projects are under way, most of them being under contract with the U. S. Reclamation Service for use of water stored in St. Mary's reservoir, in addition to early water rights on Milk River.

The Fort Belknap Irrigation District is being formed to take over and reconstruct the old system of the Fort Belknap Ditch Company, diverting from the north side of the river 8 miles above Chinook, and to cover 9,000 acres of land, three-fourths of which has already been irrigated with fair success for 25 years. A new high line canal is now being constructed by the ditch company. L. V. Bogy, of Chinook, is Secretary of the company.

The Alfalfa Valley Irrigation District was created July 7, 1920, with Fred Prosser, H. Kramer, and John Brummer, as commissioners. R. H. Clarkson of Chinook is secretary. Four thousand fifty acres are to be irrigated, lying on the north side of Milk River, between West Fork and North Fork. Most of this land has been irrigated with fair

success for about 25 years, but the present district proposes to revise the old system and enlarge and extend the Fort Belknap Ditch. Present land values within this district are from \$60 to \$75 per acre.

Zurich Irrigation District was created June 19, 1920, with Jas. Buckley, of Chinook, John W. Archer, of Zurich, and Chas. E. Farnham of Harlem, as commissioners. They propose to extend the Alfalfa Ditch to cover 12,217 acres on the north side of Milk River extending from North Fork to Harlem. Part of this land has been irrigated for some time under an old system. Present land values range from \$20 to \$60.

Petitions are being circulated for the formation of the Savoy-Coburg Irrigation District. It is proposed to take over, enlarge and extend the present ditch of the Harlem water users association. Twelve thousand acres are to be included in the district, over half of which has been irrigated for many years by the old Harlem ditch. Vernon Butler of Chinook, is promoting the project. The land lies on the north side of Milk River, extending from Harlem to Coburg.

The Paradise Irrigation District was created April 1, 1920, with W. B. Sands, J. L. Sprinkle, and W. W. Bilger, commissioners. A. W. Ziebarth, of Chinook, is secretary. Eleven thousand five hundred acres are included in the district lying on the south side of Milk River between Chinook and the Indian Reservation. Part of the land has been irrigated for the past 25 years. A new canal system is now being constructed at a cost of \$15 per acre. Present land values are around \$50 per acre.

All of the above districts have some early water rights from Milk River, and are also entering into contract with the U. S. R. S. for additional water from St. Mary's reservoir.

The U. S. Indian Department has constructed a system to irrigate 38,000 acres on the Fort Belknap Reservation. About half of this acreage is to be watered from Milk River and the balance from Whitebear, Peoples, Lodge Pole and Big Warm creeks. Only half of this irrigable acreage has been actually irrigated thus far.

The North Chinook Irrigation Association, Pierce Reeves, Secretary, irrigates about 10,000 acres of land lying several miles north of Chinook, from a reservoir constructed in 1901 to impound the flood waters of West Fork.

A few small areas in the county may be irrigated by storage on some of the intermittent streams.

BROADWATER COUNTY.

This county lies in the west central part of the state, with mountain ranges on its east and west borders and the Missouri river running from south to north through the middle of the county.

The total area is 1,250 square miles, one-fourth of which is included within the national forests. Townsend, the county seat, has a population of 900 while the total population of the county is 3,000. The assessed valuation of the county is \$15,000,000.

The Missouri valley in the central part of the county and the Crow Creek valley in the southwestern part constitute one unbroken stretch of excellent agricultural land, but having not enough rainfall to produce profitable crops without irrigation. The remainder of the county consists of grazing and timber lands. The altitude of the central valleys averages about 4,000 feet and climatic conditions are favorable for good crop yields under irrigation.

About 40,000 acres are now irrigated from the Missouri River and its tributaries, with good results. One hundred and twenty thousand acres are classified as non-irrigated agricultural lands. Most of this has been dry farmed, but for the past four years crop failures have

been common, except at the higher elevations. Grain, hay, potatoes and livestock and dairy products constitute the principal farm products. Townsend has a flour mill and an up-to-date creamery. Two railroads through the county furnish good transportation.

At Townsend the mean annual rainfall is about 10 inches and the average growing season between killing frosts is about 120 days.

Average land values are \$15 per acre for dry land and \$75 per acre for irrigated land. The soil is of excellent fertility, being mostly a black loam in the river bottoms and a clay silt on the higher lands.

Irrigation has been practiced with good results for many years by utilizing direct flow from the Missouri river and its many small tributaries.

Several large projects are now being promoted in this county. The Valley View Irrigation District near Three Forks is being developed under supervision of the Montana Irrigation Commission and is mentioned elsewhere in this report.

The Toston Irrigation District was recently organized to irrigate 5,000 acres near Toston by pumping water from the Missouri River with a lift of 100 feet and at a construction cost of \$30 per acre. Failure to dispose of the bonds when offered has delayed further progress.

The Broadwater Irrigation District has been organized to irrigate 10,000 acres by gravity from a diversion dam on the Missouri river above Toston. No bonds have been sold.



The Three Forks. Head of Missouri River

The Crow Creek Irrigation District was organized in 1919 to irrigate 54,000 acres in Crow Creek Valley, partly by storage of Crow Creek above Radersburg and partly by diversion of the Jefferson river at Twin Bridges and the construction of an 80 mile canal to bring the water over the divide at McIntire. Complete surveys are now being made to determine the cost of this project. The district is now considering the question of coming under supervision of the Irrigation Commission.

Besides these four district projects, a small area may also be irrigated by storage of the flood waters of the mountain streams particularly on Deep Creek, where a favorable reservoir site is located.

CARBON COUNTY.

Carbon County lies in the southern part of the state, adjoining the Wyoming line. It has an area of 2,100 square miles and a population of 15,000, of which 4,500 are in Red Lodge, the county seat. Bear Creek, Bridger, Fromberg, and Joliet, each with several hundred population are important towns. The assessed valuation of the county is \$28,000,000.

In the south end of the county are some of the highest mountains in the state. The north half of the county is composed of rolling bench lands and intervening river valleys. Clark Fork river and its many tributaries drain almost the entire county. Rock Creek and Red Lodge Creek are the principal tributaries. Yellowstone River borders the county on the north.

Elevations run from 3,000 feet in the north end of the county to over 12,000 in the southwest corner. About 4,000 feet is the average elevation of the irrigated lands. The benchland soils vary from heavy clay loam to light sandy loam, while the valley soils are generally a rich black loam, mixed with gravel and small boulders.

The mean annual rainfall ranges from 15 inches at Silesia to 20 inches at Red Lodge. The average growing season between killing frosts is about 120 days. The principal crops are hay, grain, sugar beets, corn, potatoes, vegetables, and some fruit. Sugar beets yield heavily, and find a ready market at the Billings sugar factory. The Northern Pacific and Burlington railroads, with two branch lines in the county, furnish ample transportation for most of the agricultural sections. Land values range from \$50 to \$200 an acre for irrigated land and from \$10 to \$50 for dry farm lands.

Irrigation has been practiced in this county for many years, with very good success. About 150,000 acres are now irrigated in the county, of this amount 70,000 acres are watered from Rock Creek, 60,000 acres from Clark Fork River, and 10,000 acres from Red Lodge Creek. The greater part of this acreage is irrigated by private ditches, though there are several incorporated ditch companies operating in each of these valleys. Rock and Red Lodge creeks have been fully appropriated and the rights therein determined by court. The amount of water so decreed are:

Rock Creek, 1,290 second feet.

Red Lodge Creek, 160 second feet.

Clark Fork River has ample water supply and has never been adjudicated, though a few of its tributaries have been decreed as follows:

Five Mile Creek, 101 second feet.

Bluewater Creek, 62 second feet.

Alkali Creek, 66 second feet.

There are three organized irrigation districts in this county. The Red Lodge-Rosebud Irrigation District was created in August, 1920, to irrigate 12,500 acres of land near Luther by a canal diverting from

East Rosebud River. This project is under supervision of the Montana Irrigation Commission and is more fully described elsewhere in this report.

The East Side Irrigation District was created in August, 1920 to irrigate 9,500 acres near Belfry by diverting water from Clark Fork River, through the old Wills Ditch, which is to be enlarged and extended. Final surveys are now being made. S. C. Kimball, of Billings, is engineer for the district.

The Joliet and White Horse Bench Irrigation District proposes to irrigate 7,200 acres of land near Joliet by storage of the flood waters of Rock Creek. This district was first created under the old irrigation district law, but recently petitioned the State Irrigation Commission to assume supervision. The project is described under the Commission's projects found elsewhere in this report.

A project to irrigate 30,000 acres from Clark Fork River near the Wyoming line was investigated several years ago, but it is understood that interstate complications prevented further development.

Some further development of irrigation in this county is possible, by utilization of the surplus waters of Clark Fork river and by storage on some of the other streams.

CARTER COUNTY.

Carter County is the southeastern county of the state. South Dakota borders it on the east, and Wyoming on the south. It covers an area of 3,318 square miles, which with the exception of the rough Blue Mud Hills in the central northern part is largely a rolling prairie. Ekalaka is the county seat. Located in the northern part, it is 42 miles from a railroad but is a well established town of 433 people and an important farming center. Pineale, the second town, is located in the southwestern part of the county. Little Beaver Creek, Box Elder Creek and Little Missouri River flow northeasterly from the county into the Dakotas. The flow of these streams fluctuates greatly, being practically dry during the summer months. The soil varies in the county. The best is a sandy loam, which is found in all sections. Clay loam and gumbo cover considerable areas. The mean elevation above sea level is 2,900 feet. The chief crops are dry land grains. Farming and stock raising are the chief industries. The chief markets are Minneapolis and St. Paul. No railroads are in the county. The Chicago, Milwaukee and St. Paul railroad offers a shipping point at Baker in Fallon County, and one at Belle Fourche, South Dakota. The county highways are good.

The county assessor's rolls show a valuation for all classes of lands as \$6,845,523 and a total valuation for the county of \$10,328,062.

Irrigation is just beginning to get a start in this county. Lack of an adequate supply during the irrigation season has retarded any development along this line. The Little Missouri Carey project in the southeastern part is now being constructed and will ultimately irrigate 20,000 acres. A more complete discussion of this project is included in another part of this report.

Similar development might be carried on along other water courses of the county. Several thousand acres are irrigable in the same manner. To facilitate this future development, gauging stations could profitably be placed on Box Elder and Little Beaver creeks. The state engineer's office is now keeping records of the flow of the Little Missouri River.

With the completion of the project now under construction, the county's valuation will be increased by \$600,000 to \$1,000,000 through the rise in value of the acreage under the project, and a railroad extension is almost a certainty.

CASCADE COUNTY.

Cascade County is located in west central Montana, and has an area of 3,400 square miles.. The total population is 39,000, of which 24,000 are in Great Falls the County seat.

The County is mostly composed of rolling bench lands, though in the southern and western parts are some rather mountainous areas. The altitude varies from 3,000 to 6,000 feet, with an average of 3,500 feet elevation. The soils vary from clay silt to sandy loam in most cases having clay subsoil. The soils are quite fertile, though excessive alkali occasionally appears.

The mean annual rainfall is 15 inches and the length of growing season varies from 71 to 140 days. The summers are hot and crops grow rapidly. Winds are prevalent and hail does some damage at times. Over half a million acres in the county are classified as tillable land. The greater part of this area has been dry farmed for several years. Wheat is the principal dry land crop, while the irrigated lands produce mostly alfalfa, oats, and potatoes. Seventy-five hundred acres are assessed as irrigated in the county.

The Missouri river runs northeast through the county and with its chief tributaries, the Smith, Belt and Sun rivers, drains most of the county and also supplies water for irrigation purposes. The county is well supplied with railroads to furnish transportation for its products. The many industries at Great Falls, make it a good local market for much of the agricultural produce. Land values range from \$15 to \$40 per acre on dry farm lands, and from \$50 to \$150 per acre on irrigated land. The total assessed valuation of the county is over \$126,000,000. Along the Missouri river just below the city of Great Falls, electric power plants deliver 165,000 H. P. of electric energy. Much further development of power is possible.

Most of the irrigated land in this county lies along the Sun River west of Great Falls. Near Cascade is also a considerable irrigated area. The Sun River has been adjudicated. Other streams of the county have not been decreed and in some the water supply is ample for a still further extension of irrigation. Several large projects are now being promoted.

Chestnut Valley Irrigation District was created in June, 1920, to irrigate 4,460 acres on the east side of Missouri river near Cascade. This project has an early water right and most of the land has been irrigated under an old system. Construction of the new system is now under way. Bonds to the amount of \$140,000 are to be issued. E. F. Lyman of Cascade is Secretary of the District.

The Fort Shaw Irrigation District was created March 2, 1920, to irrigate 13,745 acres near Fort Shaw. Construction was practically completed before the district was organized, this being the Fort Shaw unit of the U. S. R. S. Sun River project, now organized as a district for operation purposes and under contract with the Government to construct a drainage system. H. E. Culver of Fort Shaw is Secretary of the District.

The Ulm Irrigation District was created in January, 1920, to irrigate about 12,000 acres near Ulm by pumping from Missouri River with an average lift of 78 feet. A complete engineering report has been made by the district's engineers. Estimated construction cost, including partial drainage, is \$60.48 per acre. Operation and maintenance cost, including interest and depreciation, is estimated at \$7.86 per acre yearly. John W. Stanton of Great Falls is Secretary of the District.

The Sun River Bench project has recently been investigated. It contemplates the irrigation of 50,000 acres southwest of Great Falls by water from the Dearborn river to be conveyed through Flat Creek and Sims Creek and a series of canals including 15 miles of siphons and 30 miles of open canal. Reservoirs are also to be built on Dearborn river and Sims Creek. Estimated cost is \$87 per acre.

The Sunnyside Project is being promoted to organize as a district the Sunnyside unit of the Sun River Project diverting from the river near Sun River station and irrigating about 8,000 acres, on both sides of the river. Some of these lands have been irrigated by private ditches and it is proposed to acquire old water rights and cover all lands with a new canal system. Surveys have been made by the U. S. R. S. and it is proposed to co-operate with the Government in the construction and operation of this project.

The Benton Lake project is also being promoted to irrigate 70,000 acres in this county and a much larger area in Chouteau county by diverting water from Sun River through a long series of canals and coulees to Benton Lake, 8 miles north of Great Falls, where it is to be stored. Additional storage on Sun River is also required. Surveys have been made by the U. S. R. S. and it is proposed to co-operate with the Government on this project. Construction will be expensive.

The Sand Coulee Project just south of Great Falls has been favorably reported by engineers. It contemplates irrigation of 3,600 acres by pumping from Missouri River with a lift of 60 feet. The estimated cost is \$75 per acre for construction and \$6.55 per acre yearly for operation and maintenance.

At present about 40,000 acres in the county are actually irrigated. Sixteen thousand acres additional are to be irrigated by districts already organized and 128,000 acres are included in contemplated projects.

The establishment of a stream gauging station on Smith River is recommended.

CHOUTEAU COUNTY.

This county lies in north central Montana, and has an area of 4,400 square miles. Fort Benton, with a population of 1,100 is the county seat. The land consists mostly of rolling prairies and benches, broken by many washes and coulees, most of which are dry the greater part of the year. Elevations range from 2,500 to 6,000 feet above sea level, with an average of about 3,000 feet.

The Missouri river runs through the middle of the county and near Fort Benton is joined by the Marias and Teton rivers. These three rivers constitute the main source of water supply.

The soils range from the heavy clay soils to the light sandy loams, with the clay types predominating. The bench lands generally have a clay subsoil, while most of the alluvial soils along the river have a gravel subsoil furnishing good drainage but requiring a greater amount of water for irrigation.

Dry land grain and live stock are the chief products and are shipped by rail to eastern markets. Two main railroads running through the county furnish good transportation.

Climate: Temperatures at Fort Benton run from an average maximum of 97 degrees above to a mean annual minimum of 28 degrees below zero. Winds are prevalent during the spring and early summer. The average growing season between frosts is 132 days. Mean annual rainfall is 13 inches.

Assessment rolls of the county show a total agricultural area of 1,154,000 acres, only about 3,000 acres of which are irrigated. There are also 646,000 acres of grazing land in the county and a very small area of timber land. Average assessed valuations are \$8 per acre for grazing land, \$21 for non-irrigated agricultural land and \$50 for irrigated land.

For many years, a small amount of irrigation has been done by direct flow from Highwood and Shonkin creeks in the south end of the county. The total area so irrigated is about 800 acres on each of these streams. A small acreage has also been irrigated from Little Muddy, Eagle, and Birch creeks, in the northeastern part of the county. With-

in the past year several hundred acres of river bottom lands have been brought under irrigation along the Missouri and Teton rivers by pumping with electric power, the lift in most cases not exceeding 20 feet, and the enterprise being very successful. There is good opportunity for a much further development along this line. From 10,000 to 15,000 acres can be added to the irrigated area by a lift of not over 30 feet.

Missouri river has an abundance of water but its fall is so flat that irrigation by gravity is not feasible. Practically all of the waters of Teton river are utilized before reaching Chouteau County. Marias river has considerable flood water now going to waste, and a large project is being promoted to store this water for the irrigation of a large tract near Big Sandy about 75,000 acres of which are in this county.

It is also proposed to store water in Benton Lake in Cascade county and irrigate a large tract on Carter bench, lying mostly in the county. This would add another 100,000 acres to the irrigable acreage of this county. The feasibility of these two large projects is not yet fully determined.

Several hundred acres could be irrigated at reasonable cost by storing the flood waters from the intermittent stream in the southern part of the county. In several such cases natural lake beds could be utilized as reservoir sites.

CUSTER COUNTY.

Custer County is located in the eastern part of the state and has an area of 3,930 square miles. Miles City with a population of 7,937 is the county seat. The population of the county is 12,194 people. The growing season averages from 126 to 148 days. The mean annual temperature is 44.20; the mean annual precipitation is 13.19. The elevation of the agricultural land ranges from 2,100 to 2,400 feet above sea level. The total assessed value of the county is \$11,871,887. The main line of both the Chicago, Milwaukee and St. Paul and Northern Pacific railways crosses the county. There are about 17,000 acres under irrigation in the county. Most of it is being done along the Yellowstone Valley, Tongue River, Powder River, Mespaugh Creek, Johnson Creek and Pumpkin Creek.

The Tongue River Ditch, which diverts water out of Tongue River, covers an area of 9,705 acres along the Yellowstone Valley below Miles City.

There is one irrigation district filed, the Buffalo Rapids District, established in April, 1919. They proposed to divert water out of Yellowstone River by gravity and irrigate 3,700 acres along the West side of the river below Miles City. This district will be completed this fall. Bonds were issued for \$90,000.

The possibilities of future development of irrigation in this county are approximately as follows:

Along Tongue River, 7,000 acres; Pumpkin Creek, 5,000 acres; Mespaugh Creek, 5,000 acres, Powder River, 12,000 acres; Yellowstone River, 14,000 acres; Buffalo Rapids, 17,000 acres, making a total of 60,000 acres. At the present levy, this would increase the assessment of the county \$1,200,000.

It is recommended that a gauging station be placed on Powder River, also one on Tongue River and on Mespaugh Creek.

DANIELS COUNTY.

Daniels County is one of the newest counties of the state. It lies in northeastern Montana and was created from Valley and Sheridan counties. Its northern boundary is the Dominion of Canada. It has an area of 1,422 square miles. The topography is rolling bench land with a wide fertile valley along the Poplar River. The soil throughout is very fertile and productive. It is a dark loam generally. A lighter sandy loam is encountered in various parts of the county, however.

The county seat and most important town is Scobey, centrally located and the western terminal of the Great Northern branch from Bainville. Scobey has a population of 1,170 people. Madoc and Flaxville are distributing centers east of Scobey on the Great Northern of 200 people each. In the northern part Whitetail, the terminal of the Soo line from the east, has a daily train service and is an important distributing center.

The three forks of the Poplar River drain the county toward the south. The flow during the summer months is very small, but large volumes of flood water regularly pass down its channel in the spring. Most of the flow is claimed by the Reclamation Service for duty on the Fort Peck Indian Project.

The county has an average elevation of 2,500 feet above sea level and an average precipitation of about twelve inches. The chief crops are dry land grains, wheat, flax, corn and oats. Wild hay along the bottom lands of the river yields well. Some stock growing is carried on. The markets are Minneapolis and St. Paul and the Great Northern and Soo branch railroads entering from the east and terminating in the center of the county furnish transportation. In addition, a system of county highways is being worked out that will ultimately serve the entire county. The average assessed valuation of non-irrigated lands is twenty dollars per acre and of grazing lands seven dollars per acre.

Some partial irrigation has been carried on in recent years along the Poplar and its forks. The systems are of the direct diversion type depending upon the summer flow of the river. Temporary structures have generally been built and the high cost of maintenance together with complete loss in some instances has resulted in inefficient irrigation. A system of this type is installed two miles west of Scobey on the Poplar River. About 1,800 acres along the bottom have a complete system of canals and laterals, but there has never been a good dam. Three dams have been constructed during the history of the project, the first an earth dam, the second a loose stone dam, and the third a timber dam. All have been taken out by ice in the spring freshets. Steps are now being taken with a view of organizing an irrigation district to construct a permanent concrete dam. The structure will be 100 feet long and from four to six feet high of the weir type. It will divert water throughout the entire season and in addition divert enough water into a coulee, which is used as a reservoir to insure against a shortage during the growing season.

There are in Daniels County 10,000 acres of irrigable land. Water can only be supplied, however, by construction of dams for storage of spring floods. Many of the tracts irrigated in this way would be as small as forty acres.

At present, the assessment rolls carry no irrigated lands. The county's valuation through the development of 10,000 acres would increase \$250,000.

With normal rainfall conditions for dry land crops and the maximum development of irrigation possible in the county, Daniels county will take front rank as a producer in the state.

DAWSON COUNTY.

Dawson County is located in the eastern part of the state. The Yellowstone River crosses through the county. The area is 2,430 square miles. Glendive, with a population of 3,816, is the county seat. The total population of the county is 9,239. The growing season ranges from 104 to 131 days. The mean annual temperature is 42.9; the mean annual precipitation is 15.33. The elevation of the Yellowstone Valley ranges from 2,000 to 2,100 feet above sea level.

The only land in the county susceptible of irrigation is along the Yellowstone Valley.

From the county assessor's records there are 487,623 acres of agricultural land, 674,105 acres of grazing land, making a total of 1,265,815 acres. The total assessed valuation of the county is \$12,928,503. The main line of the Northern Pacific railroad crosses through the county. The eastern part of the county is served by a branch line out of Glendive.

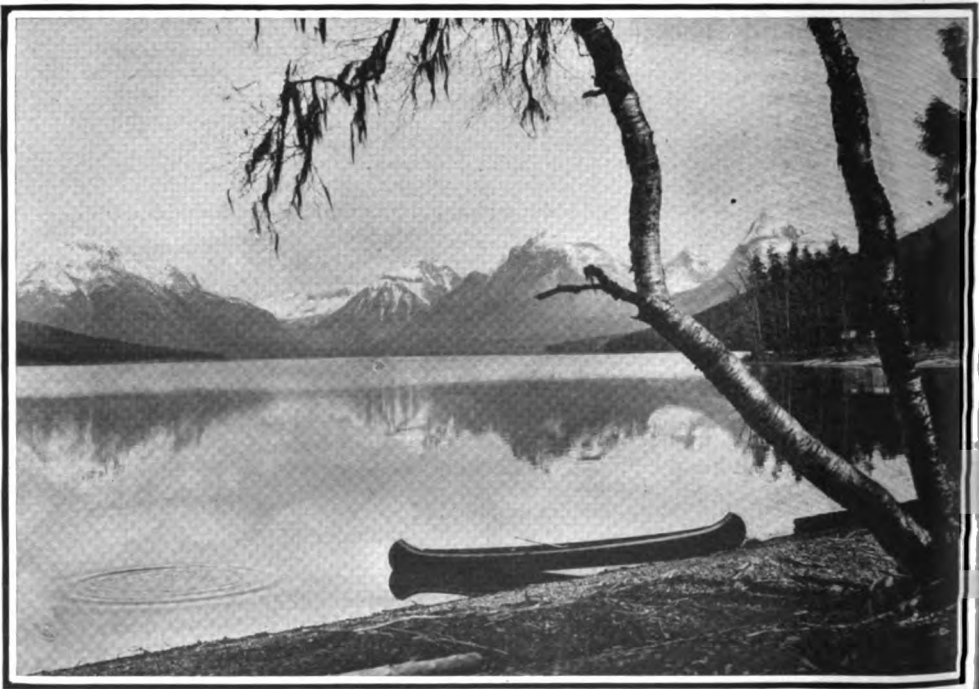
The only irrigation being done in the county is along the few benches where dams have been placed in small coulees and flood water collected. These are small scattering areas.

The United States Reclamation Lower Yellowstone Project diverts water out of the Yellowstone River in this county, but the irrigable area is in Richland County.

The only gauging station in Yellowstone County is at Intake. There have been no water rights adjudicated. The only irrigation districts which have been filed in the county are the Glendive-Fallon Irrigation Project and the Upper Glendive-Fallon Project. Both are described elsewhere in this report.

There are several pumping possibilities along the river covering about seven thousand acres. On account of the high river banks and bad lands, irrigation by gravity is very impractical.

The average assessment of land in the county is fifteen dollars per acre. There are perhaps thirty-two thousand acres within the county that will be put under irrigation in the future. This will increase the county's assessed valuation nearly one-half million dollars. There are



A Good Storage Reservoir

numerous possibilities of storing flood waters in small coulees for the irrigation of small areas. These developments will be done in the future by individual farmers.

DEER LODGE COUNTY.

Deer Lodge County is located in the central part of Western Montana. The Big Hole river forms its southern boundary. Granite County borders it on the west and Powell County on the north. Its area is 746 square miles. Anaconda is the principal town and the county seat. Its population is 11,668 people. It is largely mountainous except for the Big Hole Valley, and along Warm Springs Creek. Deer Lodge river is the principal stream in the county. There are numerous small streams. The soil in the tillable areas is of sandy loam type. The mean annual rainfall is about 13.6 inches. The average elevation above sea level is about 5,200 feet. The chief industry is smelting ores in connection with the Butte mines. Some agriculture and stock breeding are carried on. The chief crops are hay and grain and vegetables that are sold in Butte and Anaconda. The Butte, Anaconda and Pacific railroad connects Anaconda with the N. P., Milwaukee and O. S. L. railroads. The highways are excellent, a hard surface road extending from Anaconda to Butte.

The county assessor has assessed the lands of the county for a total of \$1,406,870. No classification as to whether irrigated or non-irrigated is made. The total as assessed for the county is \$30,058,426.

Irrigation along the Big Hole has been carried on for many years. Direct diversions from the river were employed. No companies or districts have ever been formed for irrigation purposes in the county. There is very little irrigated land in the county.

FALLON COUNTY.

Fallon County is located in eastern Montana and borders on the state of North Dakota. It has an area of 1,685 square miles. Baker, the county seat, is located on the railroad, in about the center of the county, and has a population of 1,067.

The general character of the county's surface is rolling prairie land, with wide valleys along the streams and water courses. The country is drained to the north, most of the streams feeding into the Yellowstone. The Little Beaver Creek flows out into North Dakota. Fallon Creek and Pennell Creek are the main streams. The soil is a chocolate loam generally. Gumbo is prevalent in parts of the county also.

The mean annual rainfall is about 15 inches. The average elevation of the county above sea level is 3,000 feet. The chief crops are wheat, oats, corn and flax. Stock raising is an important industry in connection with farming.

The railroad transportation is furnished by the C. M. & St. Paul system, the main line bisecting the county from east to west. The Billings, St. Paul and Chicago markets take most of the produce. The Yellowstone Trail, the famous highway, passes through Fallon County. The county roads are generally good.

The county assessor says \$9,806,282 is the total valuation for all classes of lands. His rolls also show the county's total assessed valuation, exclusive of railroads, etc., is \$14,308,903.

Very little irrigation has been done in the county. There is no regular supply except by storage. Since none of the streams have ever been measured the amount of water that goes to waste every spring is unknown. There are several thousand acres of irrigable land in the county. Gauging stations should be established as soon as possible on Fallon Creek and Little Beaver Creek that the extent of water available for this land be known and steps taken for its beneficial use.

FERGUS COUNTY.

This is the central county of the state. The Missouri River is its northern boundary and Mussellsell its eastern. Its area of 7,178 square miles is made up of both mountainous and rolling bench lands. Lewistown is the county seat, having a population of 6,120. Denton, 431 people; Grass Range, 262 people; Moore, 355 people, and Winnett, 316 people, are important towns.

Spring Creek, Judith River and Flatwillow Creek are the chief streams. The soil, a dark brown loam with a lime gravel subsoil, is very fertile. Gumbo soil is found in some parts. The mean annual rainfall is 19.86 inches. The agricultural areas are 3,300 to 4,200 feet above sea level. Agriculture is the chief industry. Grains, hay, stock and butter are the chief products. Oil is being produced in paying quantities. Both the C. M. & St. P. and Great Northern have lines in the county. Billings, Great Falls, Butte, St. Paul and Minneapolis are the chief markets.

The assessor's rolls at Lewistown show non-irrigated land valued at \$45,662,657 and grazing land at \$14,789,120. The total for Fergus County, including that portion of Judith Basin that was once Fergus County, is \$95,826,196, exclusive of railroad and telephone companies.

Fergus County was first settled along the streams, and irrigation ditches were built to irrigate small areas. In the Flatwillow drainage, including Box Elder Creek, about 15,000 acres are irrigated. Warm Springs and Big Springs Creeks irrigate about 9,000 acres. Flatwillow Creek is the only adjudicated stream in the county. It also has a gauging station in connection with the Carey project.

The Judith Basin Irrigation District is the only district in the county. Organized in 1919, under the district court, it proposes to enlarge an old canal from Warm Springs Creek and carry the water by gravity to land a few miles north of Danvers. Relocation of the canal and construction of several flumes are the chief features. The canal is about ten miles long and 4,200 acres are included in the project. This will be completed in 1921.

The Winnett Irrigation Company incorporated in 1911 for \$100,000 of 20,000 shares at \$5 each. The source of the water is Ford's Creek, water being diverted by gravity into War Horse Lake and Bear's Lake for storage and thence through twenty-five miles of canals to the land a few miles north of Winnett. The project has never been worked to capacity and has not been entirely successful as a unit. Areas irrigated, however, have always produced well.

South of Winnett on Flatwillow Creek is a Carey project known as the Flatwillow project. It is treated elsewhere in this report.

This county offers great possibilities for irrigation. Wolf Creek, upper Flatwillow Spring Creek, Lower Judith river all have storage possibilities. Twenty-five thousand acres of irrigable land could be irrigated with their waters. In addition, in other parts of the county the numerous small streams and coulees furnish possibilities for 15,000 acres of irrigable land.

In addition to storing irrigation water, Fergus County streams offer good opportunities for development of electric power in their lower channels. At least, 40,000 acres are irrigable in this county. When irrigated their increase in the county's assessed valuation would amount to over a million dollars. In line with this development, Spring Creek, McDonald Creek, Box Elder Creek and Wolf Creek are in immediate need of gauging stations.

Although dry land wheat gives very good results in this county, there are nevertheless many areas that would be benefited by irrigation in that more diversified crops could be produced and smaller tracts would sustain a family in as good or better circumstances than the present larger farms.

Along Wolf Creek near Stanford and farther north, near Denton, is a big acreage that could profitably be watered, if only in part, to insure moisture when it is needed. It is true that the normal precipitation is sufficient for good crops but the precipitation sometimes falls when most needed, or when it would mean a great increase in production.

Wolf Creek, a branch of the Judith river, has its source in the Little Belts. Through the summer it has very little flow, but the spring floods are very large and an immense amount of water is wasted every year. The possibilities of reservoiring this stream were examined in a general way. Ideal reservoir sites were not found, but near Stanford, and also near Denton dams could be placed which would control the flood waters.

FLATHEAD COUNTY.

Flathead County is located in the western part of the state on the Pacific slope of the Rocky Mountains. The Flathead Valley is the principal farming area. Flathead Lake is in the southern part of the county. The area of the county is 6,380 square miles. Kalispell, with a population of 5,147 is the county seat. The population of the county is 21,705. The mean annual temperature is 42.2; the mean annual precipitation is 16.95. The growing season ranges from 71 to 149 days and the mean elevation of the agricultural land is 2,500 to 3,000 feet above sea level.

From the county assessor's records, the agricultural and grazing land totals 984,587 acres; the total assessed valuation of the county is \$21,666,115. The main line of the Great Northern railroad crosses through the northern part of the county. The southern part of the county is served by a branch line of the Northern Pacific and the western part is served by a branch line of the Great Northern.

Very little irrigation has been done in Flathead County. The possibilities are many; the water supply is abundant and the soil is very productive. The streams which have been gauged are Flathead River near Columbia Falls, Flathead River below Polson, the Middle Fork at Belton, the South Fork at Columbia Falls, the Little Bitter Root River at Marion and Hubbard and the Swan River at Big Fork.

The Ashley Lake Irrigation District was organized in July, 1909. They took over the works previously started by the Ashley Lake Irrigation Company, paying \$50,000 for the old works. The total area being irrigated is 1,638 acres. The project when completed will cover 25,000 acres. Flood waters are being reservoired in both Ashley Lake and Sedan Lake. Three bond issues have been issued against the district. The first was for \$50,000, the second for \$6,000 and the third for \$7,500. The cost of maintenance, interest on the bonds and the sinking fund for 1920 amount to \$7 per acre; the total maintenance this year was \$2,854. This district has not been considered successful.

The Tally Lake Irrigation District has been recently organized to irrigate 9,347 acres. It is proposed to build a dam and reservoir at Tally Lake. The United States Reclamation Service developed a portion of the southwestern part of the county. (For description see elsewhere in this report).

Preliminary work is at present being done to form a district along the west side of the valley, water being diverted out of Flathead River at Columbia Falls. The possibilities of future development within the county are the balance of Ashley Lake project, 23,400 acres, Tally Lake project, 9,000 acres, 20,000 acres on the east side of the valley and 41,000 on the west side of the valley, making a total of 100,000 acres.

It is recommended that stream gauging stations should be located on the north fork of the Flathead River, Whitefish Creek and Stillwater River.

GALLATIN COUNTY.

Gallatin County is situated in the southern part of the state adjoining the Yellowstone National Park. It has a total area of 2,500 square miles, about half of which is included within the national forests. The population of the county is 16,000, of which 6,000 are in Bozeman, the county seat. Three Forks with 1,000 population and Manhattan and Belgrade with about 600 each, are other important towns. The assessed valuation of the county is \$56,000,000.

The average elevation of the agricultural land is 4,700 feet. Mean annual rainfall is 19 inches. Average yearly extremes of temperature are from 22 degrees below zero to 91 degrees above, and the average length of the growing season between killing frosts is 98 days.

Gallatin valley includes most of the agricultural land in the county. This valley lies well for irrigation and is watered by the tributaries of the Gallatin river. North and west of the valley proper, are rolling bench lands suitable for dry farming. The Madison river cuts through the western corner of the county and the Jefferson and Missouri rivers border the county on the northwest. The bench land soils are mostly a fertile clay silt known as "Yakima Silt Loam". The alluvial soils of Gallatin valley are a dark colored loam of high fertility, but largely mixed with gravel.

Hay, grain, live stock and butter are the chief products. The county is well supplied with railroad transportation, and local creameries and flour mills aid materially in marketing the farm products.

Gallatin Valley was among the very first areas irrigated in Montana. Water was first diverted for irrigation in 1864 and the development of irrigation in this valley has steadily increased until there are now about 140,000 acres irrigated, besides 180,000 acres of non-irrigated agricultural land and 525,000 acres of grazing land. The average assessed valuations in this county are \$105 per acre for irrigated land, \$49 per acre for dry farming land and \$8 per acre for grazing land.

Practically all of the irrigated land is within Gallatin Valley and derives its water supply from the direct flow of the several tributaries of Gallatin River. All of these streams are fully appropriated and most of them have been adjudicated after much trouble and expense. The amounts decreed are as follows:

West Gallatin River	2,093 second feet
Bear Creek (W. Gallatin)	28 second feet
Cottonwood Creek	78 second feet
Middle Creek	110 second feet
Bozeman Creek	45 second feet
East Gallatin River	"all" second feet
Bear Creek (E. Gallatin)	12 second feet
Ross Creek	4 second feet
Dry Creek	4 second feet

Under the West Gallatin decree entered in 1909, the several incorporated canals were decreed the following amounts:

West Gallatin Canal Co.	151 second feet
Farmers Canal Co.	246 second feet
Middle Creek Supply Ditch Co.	83 second feet
Spain-Ferris Ditch Co.	107 second feet
Mammoth Ditch Co.	74 second feet
Gilmore-Todd Ditch Co.	15 second feet
High Line Canal Co.	170 second feet
Low Line Canal Co.	125 second feet
Kenghen Ditch Co.	70 second feet
Valley Ditch Co.	75 second feet
Manhattan Co. (Moreland Ditch)	48 second feet
Manhattan Co. (Warm Springs Ditch)	45 second feet
Manhattan Co. (Perks Ditch)	25 second feet

About 1,200 acres of land south of Bozeman are irrigated by water stored in Mystic Lake reservoir located at the head of Sour Dough Canyon.

About 15,000 acres of land below Belgrade have become water-logged because of over-irrigation higher up the valley. A drainage district has been proposed to redeem this area but no organization has yet been effected.

In 1919 a movement was started to organize the entire valley into an irrigation district to improve the present systems and also add several thousand acres additional, by storing the flood waters of West Galatin river. Nothing further has been done on this project.

A district is also proposed to irrigate 40,000 acres of bench lands south of Manhattan by storage on Cherry Creek.

Organization of a district is now under way to irrigate 15,000 acres on south bench near Three Forks by storage on Norwegian and Willow Creeks.

Under all of these projects the lands are quite fertile and well located and would produce heavy crops under irrigation.

An organization of the entire Gallatin Valley to improve the present systems and bring about more efficient use of the present water supply is highly recommended.

GARFIELD COUNTY.

Garfield County is situated in the eastern part of the state and is bordered on the north by the Missouri River and on the west by the Musselshell. It covers a territory of 4,913 square miles, consisting largely of rolling prairie, cut by numerous dry coulees and along the Missouri River terminating in bad lands. Jordan, the county seat, is centrally located in the county on the Big Dry River and has a population of 813 people. Cohagen is in the southeastern part. Edwards is southwest about 25 miles from Jordan and Sand Springs is eight miles west of Edwards.

The drainage is by the Musselshell River and tributaries on the west side and by the Big Dry Creek in the central and eastern portions. Both streams empty into the Missouri River. Except for the Musselshell, very little water flows during the summer months in any of these courses, although springs supplying water for stock are running most of the time. The soils are varied; sandy clay loam is perhaps the most prevalent, but a heavy clay gumbo is characteristic of some sections. The mean annual rainfall amounts to 18.67 inches and the elevation is 4,700 feet above sea level. The main industry is agriculture, wheat and flax being the chief grain crops, but corn, barley, rye and oats are quite successfully raised. Stock growing is particularly good here. A good range both summer and winter is to be had. Oil development is going on rapidly and promises big results for the future. The markets of the state are not readily accessible since there is no railroad in the county. Miles City is the most available shipping point. From Jordan to Miles City is ninety miles, but this situation it is hoped will soon be relieved by the Great Northern railroad's proposed extension which is to run from east to west through the center of the county.

Considerable highway work has been done by the county and a good system of roads is rapidly being built up. The agricultural non-irrigated land of the county is assessed at \$4,852,819.00, while the grazing land is assessed at \$3,360,781. Garfield County has no irrigation works with the exception of small wells which supply a garden or small truck patch. The streams in the county are dry during the summer months and no direct irrigation from them is possible. Only by constructing dams and creating reservoirs to hold the flood waters of the spring freshets can the water be put on the land during the

growing season. While there are numerous streams flowing a considerable amount of water in the spring, good reservoir sites along these streams are scarce; the land susceptible does not always lie close by, making a long, complex distribution system necessary, and the topography of the land makes it unsuited for irrigation. The best combination is a reservoir site with the land to be irrigated lying just below it in the bottom of the creek bed.

The Big Dry Creek offers an opportunity such as this, about eight miles above Jordan. A dirt fill dam 600 feet long and thirty-five feet high would create a storage reservoir of nearly 3,000 acre feet. There are about 2,000 acres of land just below the dam site, and lying along the creek bottom that could be irrigated from this source. No data regarding the flow of this stream have ever been collected. There are numerous other opportunities in the county similar to this one although not as large. But thirty or forty acres here and there put under irrigation make a big total in all. It is estimated that 15,000 acres could be developed through small reservoirs in all parts of the county. The addition of 15,000 acres of irrigated land to Garfield County would mean an increase in value of about \$60 an acre or \$900,000, which would be added to the present valuation of the county. For purposes of comparison the Big Dry should be gauged at Jordan and at one other point at least, which would give some valuable data regarding the run-off each year from the county, and which would form a basis for computing the water available in the other water courses in the county.

GLACIER COUNTY.

This county lies in northwestern Montana just south of the Canadian line and east of the Continental Divide, and has a total area of 1,300 square miles, 90 per cent of which is included within the Blackfeet Indian Reservation. Cut Bank, with a population of about 1,200, is the county seat. Browning, with 300 population is the principal town on the reservation. The population of the county is 4,200.

The topography of the county is rough and broken, ranging from rolling bench lands in the east end of the county to steep high mountains in the west end. Altitudes range from 3,500 to 7,500 feet above sea level. Good natural drainage is provided except in some of the river valleys. The soil is generally of the clay type with occasional areas of sandy loam. All the soils are quite fertile and fairly free from injurious alkalies.

Dry land wheat is the principal crop, though some hay is raised along the streams and on the irrigated sections of the reservation. Wheat and live stock are shipped to market by rail, the main line of the Great Northern railway furnishing ample transportation.

Climatic conditions in this county are favorable for production of hay and grain and other hardy farm crops. Average temperature extremes range from 93 degrees above to 35 degrees below zero, at Cut Bank. The average growing season between killing frosts is 90 days, and the mean annual rainfall is 16 inches, about half of which occurs during the growing season.

According to the assessment rolls, there is a total of 310,000 acres of land assessable in the county, 5,300 of which are irrigated. The irrigated area is on the Indian reservation. The average assessed valuation is \$10 per acre for grazing land, \$16 to \$20 per acre for dry farm and \$35 per acre for irrigated land. The total assessed valuation of the county is \$12,700,000.

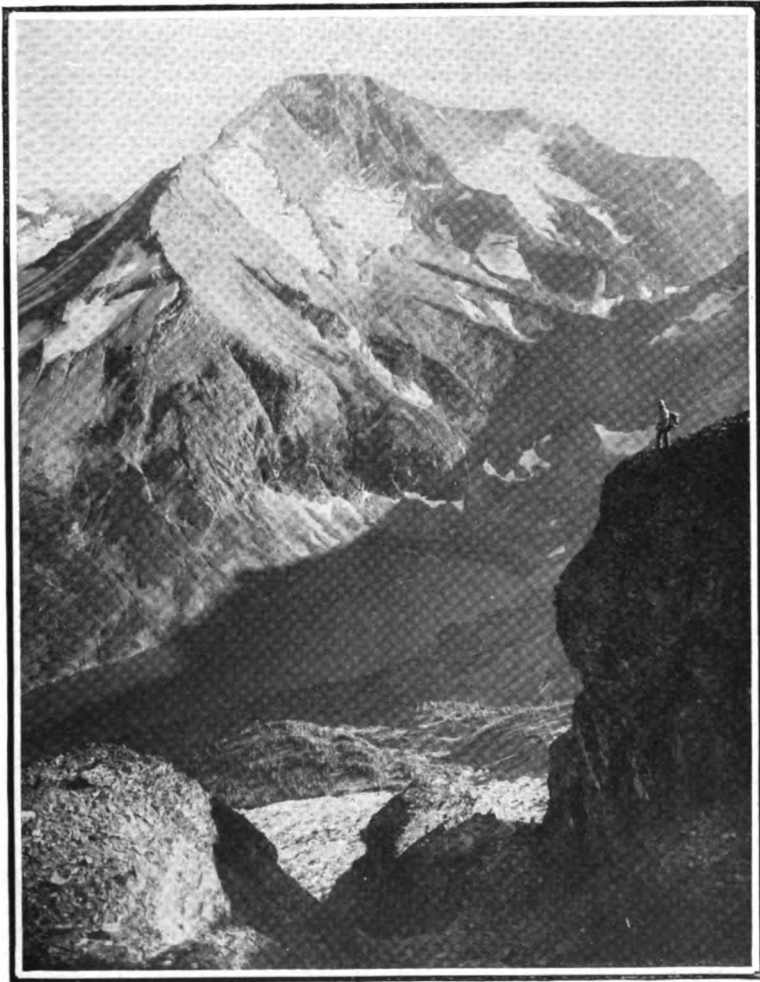
On St. Mary's lake the U. S. Reclamation Service has constructed a reservoir of 200,000 acre feet capacity and diverted the water into Milk River for use in the eastern part of the state. None of this water is used in Glacier county.

On the Indian reservation the government is constructing an irrigation system to eventually include 111,000 acres. The canals divert from Badger, Two Medicine, and Cut Bank creeks. Only 5,300 acres are thus far irrigated, although construction is completed for a much larger area.

A petition is now being prepared for the organization of an irrigation district to irrigate 11,000 acres just north of Cut Bank by extension of one of the government canals on the reservation. This is excellent land and would produce heavy crops if irrigated. C. E. Frisbee, of Cut Bank, is secretary of the district organization committee.

GOLDEN VALLEY AND MUSSELSHELL COUNTIES.

The description of the irrigation possibilities of these counties will be found under "Musselshell and Golden Valley Counties."



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GRANITE COUNTY.

Granite County is located in the southwestern part of the state. It embraces Rock Creek, Flint Creek and a portion of the Hell Gate river valleys. The balance of the county is mountainous. The area is 1,728 square miles. Philipsburg, with a population of 1,500, is the county seat; the population of the county is 4,167. The growing season averages from sixty to eighty days. The mean annual temperature is 41.07; the mean annual precipitation is 15.75. The elevation of the farming district ranges from four thousand to fifty-two hundred feet above sea level.

From the county assessor's records there are 25,254 acres of agricultural land, 21,311 acres of grazing land and 118,337 acres of timber land with a total valuation for the county of \$8,049,612.

Most of the irrigation in this county is being done along the Flint Creek Valley. There is a small acreage along the upper part of Rock Creek Valley and a few small areas along the Hell Gate River. In all, there are about 38,000 acres under irrigation. Georgetown Lake at the head of the valley has been reservoired for power purposes; also Fred Burr Lake. Twelve hundred inches of water are considered a normal flow out of Georgetown Lake which must pass the dam during the irrigating season and six hundred inches from Fred Burr Lake.

The streams which have been adjudicated in the county are Fred Burr Creek, Willow Creek, Flint Creek and tributaries, and Trout Creek. The oldest water rights date back to 1865. There are no irrigation districts within the county. There is one ditch out of Rock Creek called Munger Ditch, which diverts water into the Flint Creek Valley. The ditch was built in 1915, is seven miles long, designed to carry 1,100 inches of water and cost \$2,500 dollars. It is possible either to enlarge this ditch or build another one parallel to it and extend it so as to catch the middle fork of Rock Creek as well as the east fork and divert water into Flint Creek Valley for the irrigation of some 20,000 acres. This ditch would be perhaps ten to fifteen miles long. Moose Lake on the middle fork could be reservoired. Most of the irrigable lands are in Flint Creek Valley lying on both the east and west sides of the valley and are high, rolling bench land.

It is recommended that gauging stations be placed on the east and west forks of Rocky Creek, on Willow Creek and on Boulder Creek.

HILL COUNTY.

Hill County lies in the northern part of Montana, adjoining the Canadian line and has an area of 2,900 square miles. Havre, with a population of 5,500, is the county seat and principal town. Gilford, Hingham, Rudyard, Kremlin, Box Elder and Inverness, each with a few hundred population, are the only other towns of importance. The population of the county is 14,000.

The country is mostly rolling prairies and bench lands, cut by occasional coulees and washes most of which carry water only in flood season. Milk river is the only perennial stream in the county. Small lakes and dry lake beds abound throughout the county. There are no mountains and the only elevations of any importance are a few spurs of the Bear Paw mountains lying in the southeast corner of the county. The average elevation of the county is about 2,700 feet above sea level, the lowest being 2,400 feet and the highest about 5,000 feet.

The prevailing soil type is a clay loam, though there are some stretches with top soil of a fine sandy loam subject to more or less shifting with the wind. The soils are generally quite fertile, and when properly irrigated produce good crops, if properly drained to prevent excessive accumulation of alkali, which prevails to a certain extent

throughout the county. On dry land, wheat is the principal crop, while on the limited area now irrigated alfalfa is the chief crop. Dry land farming is attended with very uncertain results, and crop failures have been quite general for the past four years, while for a few years prior to that time excellent crops were the rule. Grain is shipped by rail to Minneapolis. The main line of the Great Northern railway furnishes good transportation facilities for most of the county.

The county has a rigorous climate, subject to great extremes, and suitable for only the hardier farm crops. Winter temperatures fall about the lowest of any in the state, while the summers are quite warm. The mean annual rainfall is 14 inches, about half of which occurs during the growing season. The average open season between killing frosts is 120 days. Winds are quite common in the spring and early summer and do much toward robbing the soil of its much needed moisture. Hail does some damage over limited areas, but the loss is not excessive.

The average assessed valuation varies from \$35 to \$50 per acre for irrigated lands, \$12 to \$18 for non-irrigated tillable lands, and from \$6 to \$10 per acre for grazing lands. There are no timber lands in the county. Assessment rolls for 1920 show 3,000 acres of irrigated land, 1,016,000 acres of non-irrigated tillable land and 321,000 acres of grazing land in the county. The total assessed valuation of the county is over \$35,000,000.

Irrigation on a very small scale has been practiced in this county for many years, with satisfactory success. A total of a little over 3,000 acres is now irrigated by private ditches, using direct flow of the river or storage of the flood waters of intermittent streams. These areas are along Milk river or in the hills south of Havre or scattered elsewhere throughout the county.

No decrees have been entered affecting water rights in the county. No irrigation districts are formed and no big projects are under construction. Two very large irrigation enterprises have been proposed and are still being agitated. These are the Saddle Butte Dam and the Marias river Project.

Surveys and soundings were made by the U. S. Reclamation Service several years ago for a large dam on Milk river near Saddle Butte. This project was finally dropped by the government but is still being advocated by some local parties.

The Marias river project contemplates the irrigation of 250,000 acres, most of which is in Hill county, and lies southwest of Havre. A dam is proposed on Marias river near Brinkman, both for storage and diversion, and additional storage is to be provided in Lonesome Lake. This project was investigated by the U. S. Reclamation Service in 1902 and 1904. Last year the Marias River Development Association revived the project and now plans to develop it as an irrigation district. The estimated cost is \$10,700,000.

The lands of this county lie well for irrigation, but since the water supply is limited, most of the county must forever remain unwatered. A considerable irrigation development is possible by storage in small units along the many coulees and in the dry lake beds.

Because of the uncertainty of dry farming and the large percentage of crop failures in this county, present land values are very low. Irrigation would increase these land values at least fourfold. Under such conditions a cost of \$50 per acre for irrigation would be justified.

The establishment of a stream measurement station on Marias river near Brinkman is recommended.

JEFFERSON COUNTY.

Jefferson County lies in the west central part of Montana with the Continental Divide forming its western boundary and extending from Helena Valley on the north to the Jefferson River on the south.

The county has a total area of 1,650 square miles and a population of about 5,000. Boulder, with 500 inhabitants, is the county seat. Other leading towns are Whitehall, Basin and Clancy.

The county is mostly mountainous, ranging in altitude from 4,000 to 8,000 feet. The irrigable lands are mostly between 4,000 and 5,000 feet elevation. About half of the total area of the county is included in the National Forests and a large part of the remainder is hilly country best adapted to grazing purposes.

The greater part of the county is included within the drainage area of the Boulder River. The north end of the county is tributary to Prickly Pear Creek, while a considerable acreage in the south end of the county is drained by Whitetail and Pipestone creeks. The above-named streams, together with the Jefferson River furnish the only available sources of water supply for the county.

The soils throughout the county are quite fertile, ranging from deep heavy clays to light sandy loams, and are generally free from injurious alkalies. The topography is such as to provide good natural drainage, and little or no water-logging of the land results from irrigation.

At Boulder, the mean annual rainfall is about 18 inches, one-third of which occurs during the growing season. The average length of the growing season between killing frosts is about 80 days. The majority of the irrigable lands is at a lower elevation and has a somewhat longer growing season than at Boulder.

Mining, agriculture and stock raising are the principal industries of the county. Hay and grain are the chief crops of the farm. Transportation facilities are favorable. Grain and live stock are shipped east by rail, while other farm products find a ready market in Butte and Helena.

The average assessed valuation is about \$20 per acre for grazing and dry farm lands and about \$50 for irrigated lands. The total assessed valuation of the county is about \$18,000,000.

Irrigation has been practiced for many years, principally in small units, and only recently including projects of any importance. Most of the available water supply is now appropriated and further irrigation development must depend principally upon storage of the flood waters.

Water rights on most of the streams have been adjudicated. The amounts so decreed are as follows: Prickly Pear Creek, 199 second feet; McClellan Creek, 17 second feet; Clancy, 2 second feet; Muskrat Creek, 32 second feet; Elkhorn Creek, 49 second feet; E. Fk. Elkhorn Creek, 11 second feet; Whitetail Creek, 83 second feet; Pipestone Creek, 67 second feet; being a total of 460 second feet of water decreed. On the other streams recorded appropriations are as follows: Boulder River, 4,900 second feet; Little Boulder River, 340 second feet; Little Whitetail Creek, 50 second feet; Bison Creek, 284 second feet. As these amounts are far in excess of the available water supply, the figures have little significance.

Official stream measurements have been made at different times on Boulder River and Muskrat, Whitetail and Pipestone creeks. The results are published in the biennial reports of the state engineer. The direct flow of these streams is practically all utilized for irrigation during the late summer, with the exception of the Boulder River below Coldspring. Here some additional irrigation is possible without storage.

The total area now irrigated is about 30,000 acres, being mostly included in small private projects. About 3,000 acres are on the Prickly Pear, 5,000 acres on the Boulder, 2,000 acres on Whitetail, 4,000 acres on Pipestone Creek and about 8,000 acres from Jefferson River. Three thousand acres of the above total are irrigated by storage water and the balance by direct flow. No pumping is required.

The Jefferson Canal Company, with 2,500 acres and the Pipestone Ditch Company, with 1,200 acres, have the largest units under direct flow. The Pipestone Canal and Reservoir Company irrigates 3,000 acres by storing the flood waters of Pipestone Creek.

There is now under construction on west fork of Whitetail Creek a reservoir to irrigate 4,000 acres at a cost of \$50 per acre. This project was organized as an irrigation district in March, 1919, but failed to sell bonds for construction and is now being developed with private capital.

Additional irrigation is possible by storing the flood waters where feasible reservoir sites are available. Waters of the Boulder River may be stored about five miles below the town of Boulder to irrigate about 8,000 acres on the west side of the Boulder opposite Finn P. O. A reservoir on the Little Boulder will irrigate 2,000 acres near Boulder town. Storage on Whitetail will irrigate 2,000 north of Whitehall. A reservoir on Fish Creek will add 2,000 or 3,000 acres more to the irrigable acreage.

Gauging stations should be maintained on Boulder River near Basin and again near Cardwell. Little Boulder Creek should also be measured to determine available supply for storage.

JUDITH BASIN COUNTY.

Judith Basin County was created from eastern Cascade and western Fergus counties and embraces a large territory of the famous Judith Basin. Its area covers about 1,894 square miles. The Little Belt Mountains in the south break off into a rolling country in the north and east. The Judith River, flowing northeast drains the bigger part of the county. The soil is a rich chocolate loam underlaid with lime gravel. The Great Northern from Great Falls to Billings passes through the county.

Stanford with 355 people and Hobson are the most important towns. The average elevation of the agricultural areas is 4,300 feet. An average yearly rainfall of 19 inches makes dry farming successful. The chief crops are grains, hay and vegetables. Stock is raised extensively and dairying is a growing industry. The chief markets are Great Falls, Billings, St. Paul and Minneapolis. Agricultural lands are valued from \$25 to \$125 per acre.

Irrigation practiced along the Judith River and Wolf Creek covers 25,000 acres. Three gauging stations on the tributaries of the Judith River have recently been established in order that definite data regarding these streams can be collected. In the vicinity of Stanford there are 5,000 acres of fine irrigable land. The waters of Wolf Creek will have to be reservoired and conveyed by gravity to these lands.

Along the Judith River in the vicinity of Hobson and south of that city there is a large area of irrigable land. About 122,000 acres are irrigable. The general scheme calls for reservoiring Judith River and its tributaries and conveying the water onto the land by gravity through two main canals.

The soil and climatic conditions are excellent and the topography of the proposed area is well suited to irrigation. In all, there are about 130,000 acres of irrigable land in this county. The extreme fertility of the soil, and the good growing conditions rival those of the best irrigated sections of the state. It is reasonable to expect that irrigated land in this county will reach a value of \$200 an acre or at least an increase of \$50 an acre. The total increase in valuation of the county would thus extend to several millions of dollars.

LEWIS AND CLARK COUNTY.

This county lies in west central Montana with the Continental Divide forming part of its western boundary and a considerable acreage of the county also extending west of the Divide. It has a total area of 3,500 square miles, over one-third of which is included in National Forests. About 50,000 acres are irrigated and several times that amount

are dry farmed. The population of the county is 18,500. Helena, with 12,800 people is the county seat as well as state capital. The assessed valuation of the county is \$63,000,000.

The county is mostly mountainous with many intervening valleys admirably adapted to irrigated farming. The altitude ranges from 3,500 to 7,500 feet elevation with 4,000 feet as the average elevation of the irrigable lands.

Missouri river runs northward through the eastern part of the county. Its principal tributaries in the county are Dearborn and Sun rivers and Prickly Pear and Little Prickly Pear Creeks. These are the chief sources of supply for irrigation. Three large dams and power plants on Missouri river within the county produce 65,500 kilowatts of electric power.

The soils vary from heavy clay silt to light sandy loam with clay subsoil. All are quite fertile. Grain, alfalfa and potatoes are the leading crops. Great Falls, Helena and Butte furnish near markets for much of the produce. The Great Northern Railway, running north and south through Helena and the Northern Pacific Railway running east and west furnish ample transportation to the south end of the county. A branch line from Great Falls to Gilman serves the extreme north end of the county.

Because of the mountain protection, this county has a more equable climate than many other parts of the state. The length of the growing season is from 90 to 140 days. The mean annual rainfall at Helena is 13 inches.

Irrigation has been practiced in this county for many years, and most of the low water flow of the streams is utilized, but a great increase in irrigation is possible by storing the flood waters and by pumping from Missouri River. Water rights have been adjudicated on most of the streams of the county.

In Helena valley about 10,000 acres are irrigated from Prickly Pear Creek and a few thousand acres more from Ten Mile and Seven Mile Creeks. On the north side of the valley 6,600 acres are irrigated by pumping from Lake Helena with an average lift of 110 feet. Southeast of Lake Helena, 3,500 acres are irrigated by pumping to a height of 160 feet.

Near Canyon Creek 5,000 acres are irrigated from Prickly Pear Creek, and in the north end of the county an equal amount is irrigated from Sun River. About 3,000 acres are irrigated from Dearborn River.

The Helena Irrigation District was created in August, 1920, to irrigate 16,000 acres near East Helena by pumping from Lake Helena with an average lift of 180 feet.

A large project was started about 15 years ago to irrigate 36,000 acres south of Gilman by storing and diverting the waters of the Dearborn river. After constructing 20 miles of ditch at a cost of \$200,000 the project was dropped. A movement is now under way to revive this project and complete it as an irrigation district.

Many areas of excellent irrigable land are found in the county, much of which can be irrigated by storage of flood waters on the different streams. Several feasible reservoirs are available for this purpose.

Stream gauging stations should be maintained on Canyon creek and on Dearborn river.

LIBERTY COUNTY.

Liberty County is located in the northern part of Montana, adjoining the Canadian border. It is one of the newest counties of the state, having been created in February of the present year. It is bounded east by Hill County, south by Chouteau County, and west by Toole County, and has a total area of 1,458 square miles.

Chester with a population of 400 is the county seat. Other towns are Joplin with 300 and Lothair with 100 population. The topography

is mostly rolling prairie, with occasional bluffs and washes. The Sweetgrass hills occupy the northwest corner of the county. Marias river is the only perennial water course. Eagle and Cottonwood creeks are intermittent streams. The average elevation above sea level is about 3,300 feet, the lowest being 3,000 feet in the southeast corner of the county, and the highest 5,000 feet in northwest corner. The prevailing soil type is clay loam, with clay subsoil; some strips of sandy top soil are found. The average soil is quite fertile but carries a considerable percentage of alkali, which for lack of moisture has not yet become very evident.

The mean annual rainfall is 12 inches. Dry land wheat is the principal crop, but because of drouth for the past four years this crop has been almost a failure. The main line of the Great Northern railway furnishes ample transportation for at least half of the county.

The total assessed valuation of the county is \$12,000,000, over \$8,000,000 of which represents land valuation. Irrigated lands are assessed at \$35 per acre, non-irrigated farming land at from \$12 to \$18 per acre, according to distance from the railway, grazing lands at from \$6 to \$10 per acre. Assessment rolls for 1920 show 940 acres irrigated, 466,372 acres tillable and 201,805 acres grazing lands. There are no timber lands in the county. Of the small acreage irrigated in the county about one-third is along Marias River, one-third on Eagle creek, and one-third on Cottonwood creek.

The irrigation on Marias river is in small patches along the river bottoms. On Eagle creek the limited area irrigated is scattered among ranches on the headwaters of the stream. On Cottonwood creek part of the irrigation is from storage of the flood waters. Prescott's ranch has a reservoir for irrigation purposes.

Prospects for extension of irrigation are not very encouraging. Marias River has but little fall, while the lands are high above the river. The other streams are dry most of the year. Some flood waters of Cottonwood and other smaller streams may be stored for a small acreage irrigated in that way.

A movement is on foot to organize an irrigation district and contract with the Toole County Irrigation District for the extension of their proposed system to irrigate lands in this county. This would bring a large acreage under irrigation, but the feasibility of such a project has not yet been determined.

Because of the recent drouth, the present condition of the county is rather discouraging. Irrigation is badly needed but the prospects of securing irrigation to any extent are very uncertain. If irrigation does prove feasible, this county has a good future; if not, improved methods of dry farming must be practiced in order to secure paying crops without irrigation.

LINCOLN COUNTY.

Lincoln County is located in the extreme northwestern corner of the state on the Pacific slope of the Rocky Mountains. The larger part of the county is mountainous and covered with heavy timber. The Kootenai River flows into the county from Canada and across the state line into Idaho. The majority of the river bottom is narrow and covered with timber or stumps. A very small proportion is cleared and farmed. Tobacco River flows into the Kootenai in the northeast corner and Fisher River from the southern part and Yaak River from the northwest corner. The soil is a very rich loam, which is very productive when cleared of brush and timber.

The area of the county is 3,660 square miles. Libby with a population of 1,522 is the county seat. The population of the county is 7,797. The growing season averages from 46 to 97 days. The mean annual temperature is 44.90; the mean annual precipitation is 22.68. The elevation of the agricultural land ranges from 1,800 to 3,000 feet above sea level. The Kootenai Valley has the lowest elevation within the state.

The main line of the Great Northern railway crosses through the county. The county assessor's records make no distinction between irrigated, non-irrigated, grazing and timber lands. The total assessed valuation of the county is \$7,382,090.

From the United States census of irrigation, there are 13,114 acres susceptible of irrigation by new works being completed or just completed. Eight thousand seven hundred and thirty acres can be irrigated by works already constructed and 5,349 acres are actually being irrigated.

The streams which have been measured are the Kootenai River near Libby, Callahan Creek near Troy and the Yaak River near Troy. There are no streams in the county which have been adjudicated.

The mean annual flow of the Kootenai River shows that 8,284,000 acre feet leave the state flowing into Idaho. At a duty of three acre feet, this would irrigate 1,761,000 acres. Unfortunately, the water supply is much greater in this watershed than there is land susceptible of irrigation.

There is only one irrigation district within the county and that was created under the jurisdiction of the court in February, 1910. A bond issue of \$112,000 was authorized and sold. It is proposed to divert water from Therrault Creek into Lick Lake which is reservoired. From there water flows to Glen Lake which is also reservoired. The irrigable acreage under this project is 4,117 acres. Comparing this with data obtained by the United States Census Bureau, it shows that 1,232 acres outside of this district are being irrigated by small enterprises. The yearly assessments in the Glen Lake district to pay for maintenance, sinking fund and interest on the bond issue are for 1918, \$4.50 per acre; 1919, \$4.38 per acre; 1920, \$4.74 per acre.

There is at present a district proposed near Libby which will divert water out of Pipe Creek. This will cover approximately five thousand acres.

Within the entire county, there are about 190,000 acres of land that are still susceptible of irrigation. Most of this is stump land, which brings up the question of the cost of clearing in addition to the cost of reclamation.

It is recommended that gauging stations be established at Pipe Creek, Fisher River, Cherry Creek and Libby Creek.

MADISON COUNTY.

Madison County is situated in southwestern Montana, between the Ruby Mountains on the west and the Madison Mountains on the east, the continental divide being the south boundary. The topography is mountainous, cut by two large north and south valleys where the agricultural land is located. The average elevation of agricultural areas is 5,000 feet above sea level. The Ruby River flows northward through the western side. The county has an area of 3,588 square miles. Virginia City, the county seat, a town of 342 people, is in the heart of the mining section. Sheridan, with 538 people, and Twin Bridges, 755 people, are in the Ruby Valley. Pony, a town of 242 people, and Ennis, a town of 150 people, are in the Madison Valley. The main streams are Madison, Ruby and South Boulder, but there are many important tributaries, most of which are adjudicated.

Farming, stock raising and mining are the chief industries. Grain, hay and vegetables are the chief crops. Two branch lines of the Northern Pacific Company, one on the east side and one on the west side, furnish transportation to the Butte and eastern markets. The Park highways traverse the county and the roads generally are very good.

The assessor's books show irrigated lands having an assessed valuation of \$5,552,978; non-irrigated lands having an assessed valuation of \$1,043,778; and grazing lands having an assessed valuation of \$4,322,504.

Large areas are now under irrigation along the streams and rivers of the county. The Madison Valley has about 35,000 acres of irrigated lands while the Ruby, Jefferson and Beaverhead have, with their branches, about 50,000 acres. The northern end of the county, including the South Boulder country, has about 15,000 acres under irrigation. Most of this acreage is irrigated by private ditches, there being no large districts or projects in use. A gauging station on the Ruby River, about eight miles south of Alder, was established in 1911 but was discontinued in 1914. Gauging stations could profitably be placed on Camp Creek near Melrose, and on Norwegian and Willow Creeks in the north-eastern part of the county.

One irrigation district has been formed in Madison County. This one, known as the Madison Valley Irrigation District, was organized in 1916, to water 1909 acres of bench land on the west side of the Madison River, near Ennis.

In 1919 the land owners co-operated and completed the project as a company. The water is diverted directly from the Madison River at a point about four miles south of Ennis and is carried by canals and flumes to a point near McAllister. This year, 1920, saw the first full season's operation, which is considered very successful. It will be enlarged to serve the 3,200 acres later. The chief crop is hay. The cost of the project approximated \$18 per acre.

A similar project on the bench lands, just above the Madison Valley Irrigation District, can be utilized to water from 5,000 to 7,000 acres of good bench land.

The soil is a silty loam and abounds in lime. The altitude is about 5,200 feet above sea level. The canal would be about 20 miles in length, diverting directly from the Madison River. No serious engineering obstacles would be encountered.

The Madison Irrigation Project is the name given to a system proposed on the east side of the Madison River, embracing some 30,000 acres of good land. The general topography is smooth bench land sloping about 25 feet to the mile. The soil is a silty loam with considerable lime ingredients. The average elevation of the lands is 5,500 feet above sea level.

The engineering work consists of a 40 mile canal diverting directly from the Madison River at a point about a mile above Lyon. Several stream crossings are encountered in bringing the canal to Jack Creek northeast of Jeffers, where it terminates, but none is extremely difficult. This project is expected to develop within a short time, a preliminary survey having been made several years ago. Construction of this project will have some influence, tending to the extension of the railroad from Norris into the upper Madison Valley.

On the Ruby River side a large area of dry land, extends along the bench on the west side of the river from Alder to the Beaverhead county line and north to the junction of the Beaverhead and Ruby Rivers. This area was once embraced in a Carey Act Project but has been canceled. The land consists of rolling bench land sloping about 25 feet to the mile. The average elevation is about 5,300 feet above sea level.

The development of this project necessitates the construction of a dam in the Ruby River and a main canal about 30 miles long. To store the requisite amount of water in the available reservoir requires a dam 125 feet high and 400 feet long on the crest. The dam site is so situated that a rock and earth fill dam could be constructed. The reservoir site is now occupied by two home ranches which would have to be bought out. About $2\frac{1}{2}$ miles of highway would have to be relocated and constructed. In the main canal about two miles of expensive construction will be encountered, after which the work will be easy.

Similar bench lands on the east side of the Ruby River can be watered from the same source, though here several bad creek crossings are encountered, Alder Gulch being the worst, as the natural contour of

the country here has been affected by the dredging operations of the past. Operation of this project would develop about 25,000 acres of land.

Madison County abounds in water power sites, owing to the great fall in most of its streams. The Montana Power Company has developed a large power site and reservoir and a huge storage reservoir on the Madison River. This county has great possibilities for irrigation, as its numerous streams and acres of dry land are generally situated to combine ease of construction and low cost of development. At least 60,000 acres of land, valued at \$10 to \$25 an acre now, can be irrigated and be valued at \$30 to \$60 an acre, a net increase to the county of upward of a million and a half dollars.

McCONE COUNTY.

McCone County lies in northeastern Montana. The Missouri River is its northern boundary. Garfield County borders it on the west with Richland and Dawson counties on the east.

The county contains 2,740 square miles. Its topography is rolling and has large flat benches. The soil is a clay loam in the valleys and a sandy loam on the benchlands of great fertility. Circle is the county seat, is centrally located and has a population of 452 people. Brockway, a town of 150, is twelve miles west of Circle. Redwater Creek is the largest stream, heading in the southern part and flowing northeast. McGuire Creek and Sand Creek drain out to the north into the Missouri River. The mean annual rainfall for this section is 19.7 inches. Its elevation above sea level is about 2,800 feet. Wheat, oats, barley, rye and corn are the chief crops. Some alfalfa and vegetables are also grown. Butter is manufactured at Brockway. In addition to farming, stock raising is an extensive industry. McCone County has no railroads within its borders. Richey, the terminal of the Great Northern in northern Dawson County and Terry on both the Northern Pacific and Milwaukee railroads, are the chief outlets for the county's produce. Minneapolis and St. Paul are the chief markets. The county highway system is well laid out and the roads are generally in good shape.

The assessed valuation of irrigated land in the county is \$14,700, of non-irrigated land is \$8,084,849 and of grazing land is \$2,695,343 as taken from the county assessor's records. They also show the total assessed valuation of the county as \$16,702,519.

The streams do not flow very much water during the growing season and as a result but little irrigation has ever been done. There are no gauging stations established in the county. Some unofficial records have been kept at Brockway on Redwater Creek, Ash Creek and Duck Creek during the past year. In 1910, an earth dam was privately built near Brockway on Ash Creek, a tributary of Redwater Creek. It developed a storage reservoir of 200 acre feet and 100 acres were prepared for irrigation. It failed after the second year's use and was never rebuilt.

The Brockway Irrigation District was formed under the Montana Irrigation Commission in 1919 to irrigate 2,740 acres. A complete resume of this project is included in another part of this report.

The only irrigation system in the county is located in the northeastern part along Wolf Creek. This project was privately built ten years ago by constructing an earth dam in Wolf Creek and creating a storage of 3,588 acre feet. Additional work has been done from time to time and the present dam and reservoir are very substantial. About 600 acres are successfully irrigated and the full capacity of the reservoir has never been needed. This is an example of the general system that must be used for future irrigation in the county. There is considerably more land irrigable than water available, but a conservative estimate places the net irrigable land in the county at 20,000 acres. In addition, pumping from drilled wells on small areas would develop several thousand acres. If this land should be irrigated, it would be

very advantageous to the county. At least a valuation increase of \$40 an acre can be expected, which would total in all \$800,000. With construction of the proposed Great Northern railway, also, McCone County will take rank as one of the best in Montana.

MEAGHER COUNTY.

Meagher County, comprising an area of 2,369 square miles is situated in central Montana between the Big Belt Mountains on the west and the Little Belts on the north and east.

The general topography is mountainous with numerous streams and valleys. Smith River, the main stream, rises in the southeast and flows in a northwesterly course. The Musselshell River drains the extreme eastern part toward the east. White Sulphur Springs is the county seat and is a town of 574 people. Martinsdale is the chief town in the eastern part of the county.

The Milwaukee railroad crosses the southern part of the county from east to west and a branch connects Ringling to White Sulphur Springs. The Butte and eastern markets are most accessible. Meagher County's highways are excellent; the Park to Park highway passes through the center of the county. Agriculture and mining are the important industries; dairy products, stock, grain and hay are the important products. The average rainfall is 11.2 inches. The average elevation above sea level for the agricultural areas is 5,000 feet. The soil varies from sandy loam on the benches to clay loam in the valleys.

From the assessor's assessed valuation records, the following was obtained. Irrigated lands have a value of \$1,304,805, non-irrigated lands \$2,318,307, and grazing lands \$5,911,664. The total assessed valuation, exclusive of railroads and telephone systems, is \$21,000,000.

The history of irrigation in the county is similar to that of the other older sections of the state. Canals and works were constructed by individuals or partnerships to water the most accessible areas along streams and rivers. Most of the 35,000 acres of irrigated lands lie in the Smith River valley and its tributaries, although the north and south forks of the Musselshell River bottoms are also watered. Many of the streams have been adjudicated.

No irrigation companies or districts are in operation at the present time. Some small reservoirs have been constructed by individuals to store water for use but no large operations of this kind have developed. This county has some good possibilities for reservoiring the winter and spring water flowing away from it for use on the dry areas within its boundaries. Most of the streams head far up in the mountains where the snowfall is heavy. On the eastern slopes in the Musselshell drainage are located lands that could be irrigated through the conservation of the flood waters of Flagstaff, Muddy, Haymaker and Cottonwood creeks. Although reservoirs on these streams are rather expensive in first cost, the fact that they are immediately adjacent to the land, increases the duty of the water enough to make a reservoir on these streams feasible.

On the Smith River side in Range 8 East, Township 10 North, a reservoir site known as the Magnolia Basin, has some good possibilities for development. This site while not located in the river bottom, can be filled by the use of a diversion ditch from the Smith River. The land susceptible through the development of this reservoir lies a few miles below, being rolling lands of good soil and climatic conditions. About 4,000 acre feet of water could be stored. Lower on the Smith River a few miles above White Sulphur Springs, is located a reservoir site privately owned and which it is contemplated will some day be developed. This storage would increase the owners' present supply of water, besides making some available for the reclamation of the dry land lying near the town.

Two proposed projects below White Sulphur Springs in the river valley, Wood's Gulch and Newlan Creek, respectively, are now under

consideration by the Montana Irrigation Commission. An account of these is found elsewhere in this report. A direct diversion from Smith River, near the mouth of Birch Creek, contemplates watering 600 to 1,000 acres, and while this project requires some heavy construction work, including considerable fluming, its feasibility is assured.

An interesting experiment is under consideration on the land lying between the north and south forks of Smith River near the junction. Here the water table is very high, in the spring lying just below the surface of the land. It is now contemplated to construct a long narrow trench through this water logged land, thus creating a drain for that section and a supply of surface water for the land below. This plan is in successful use in many other sections.

In the southern portion of the county, Sixteen Mile Creek, having its source in a snowy section unprotected by timber, has a large spring run-off and a small regular flow. About eight miles above Ringling there is a reservoir site which is available for storage purposes. At one time there was an earth dam in place here that failed. It is the present plan to construct a permanent structure. About 5,000 acres of irrigable land lie in this part of the county.

Some 20,000 acres can be changed from dry or partially irrigated land, valued at from ten to thirty dollars per acre, to well irrigated land with a valuation of \$40 to \$60 per acre. This makes an increase to the county of from \$400,000 to \$600,000 in valuation.

Several good dam sites for power purposes where the fall of the water and not the amount of the water stored is important are available for development in the county. The Montana Power Company is expected to furnish electric power within the county in the near future. Measurements on all the important streams are to be desired and measurement of the other streams might be made to good advantage. Data on the Smith River and Sixteen Mile Creek run-offs should by all means be secured to determine just what the possibilities of these streams for irrigation are and to allow for their full utilization.

MINERAL COUNTY.

Mineral County is located in the extreme western part of the state on the Pacific slope of the Rocky Mountains. The Clark's Fork of the Columbia River and the St. Regis River flow through the county. The only agricultural land in the county consists of narrow intermittent areas along the river valley. The balance of the county is mountainous and is covered with timber. The county is well watered with very small areas susceptible of irrigation. The area of the county is 1,224 square miles. Superior, having a population of 865, is the county seat. The total population of the county is 2,327. The elevation of the agricultural land ranges from 2,700 to 3,000 feet above sea level. The growing season is 115 days. The mean annual temperature is about 44 and the mean annual precipitation is about 16 inches. The soil throughout the county is generally sandy loam with considerable areas of gravel and boulders. The chief crops are hay and grain. Lumbering is one of the principal industries. The main lines of both the Northern Pacific and the Chicago, Milwaukee and St. Paul cross lengthwise through the county. From the county assessor's records, there are 619 acres in the county under irrigation, 3,913 acres of agricultural land, 56,064 acres of grazing land and 109,933 acres of timber with a total assessed valuation of \$1,688,771.

There are no irrigation districts in the county nor any large irrigation companies. Nearly all the land that is being irrigated consists of small patches irrigated from individual ditches. There are about one thousand acres in the county under irrigation.

Streams in the county which have been gauged are Clark's Fork of the Columbia near St. Regis and St. Regis River near St. Regis. The streams which have been adjudicated are Thompson Creek and

Crow or Timber Creek. There is a possibility of irrigating three thousand acres on Miles Flat, two thousand acres above Miles Flat and one thousand acres at St. Regis; making a possible total of six thousand acres. At the present rate of assessment this would increase the county's assessed valuation by \$480,000.

There is a possibility of a reservoir site at Demote Creek four miles east of Quartz. This would cover the Miles Flat. No data are available on the reservoir capacity.

There are many possibilities of power development along the river which could be used for pumping projects. Most of the way through the county the river flows through a deep narrow gorge and the irrigable land lies on the benches from one to two hundred feet higher, thus making gravity systems impossible in many places.

It is recommended that a gauging station be located on Demote Creek.

MISSOULA COUNTY.

Missoula County is located in the western part of the state on the Pacific slope of the Rocky Mountains. The principal valleys are Missoula Valley and the lower end of the Bitter Root Valley in the southern part of the county, the lower part of Flathead Valley in the northwestern part of the county and the Swan River Valley in the northeastern part of the county. The county is mountainous save for the valley areas. The principal water courses are the Clark's Fork of the Columbia River, the Flathead River, the Blackfoot River and the Swan River. The area of the county is 3,022 square miles; the population is 24,041. The county seat is Missoula and its population is 12,668. Other towns of importance are Ronan, St. Ignatius, Frenchtown and Bonner.

The soil is usually a good quality of sandy loam along the river bottoms. The Flathead Valley and also the area immediately west of Missoula are composed of a sandy clay formation. The growing season averages about 115 days. The mean annual temperature is 43.5. The mean annual precipitation is 15.73. The elevations of the valleys range from 3,200 to 4,000 feet above sea level. The principal crops are grain, hay, dairying and stock raising. Lumbering is an important industry. The chief markets are the mining districts in the Coeur d'Alene and Butte. Both the main line of the Northern Pacific and that of the Chicago, Milwaukee and St. Paul railways cross the southern part of the county.

From the county assessor's records, there are 155,159 acres of land irrigated assessed at \$4,726,475; 168,270 acres of agricultural land non-irrigated assessed at \$3,168,015; 134,645 acres of grazing land assessed at \$947,070 and 515,016 acres of timber land assessed at \$4,614,354, making a total assessed valuation of \$20,500,144.

There are approximately 100,000 acres of land under irrigation in the county; the U. S. census returns show that 344,033 acres will be irrigated by new works either completed or under construction and that 219,476 acres are susceptible of irrigation by works already constructed and that 101,026 acres are being irrigated.

The following is a list of streams which are being gauged or in which miscellaneous stream measurements have been made:

Big Blackfoot River at Bonner, Rattlesnake at Missoula, Bitter Root seven miles southwest of Missoula, Lolo near Lolo, Rock Creek near Quigley, Clark's Fork of Columbia at Missoula, Crow Creek four miles south of Ronan, Mud Creek three miles northwest of Ronan, Mission Creek one mile below St. Ignatius, Dry Creek three and one-half miles southeast of St. Ignatius, Post Creek ten miles south of Ronan, Post Creek near Ronan, Jocko River one and one-quarter miles northwest of Jocko, Jocko River at Ravalli, Big Knife Creek near Jacko, Big Knife Creek two and one-half miles northeast of Jocko, Agency Creek two miles east of Jocko, Blodgett Creek one and one-half miles northeast of Jocko, Finley Creek two and one-half miles south of Jocko,

East Finley Creek four miles southeast of Jocko, Indian Ditch near Jocko, Valley Creek three miles east of Ravalli, and Revals Creek four miles northwest of Dixon.

There have been only two irrigation districts filed in the county, the Clinton Irrigation District and the DeSmet Irrigation District. The Clinton district was created in September, 1919, but did not come under the jurisdiction of the Montana Irrigation Commission. They proposed to divert water out of Hellgate River two miles east of Clinton covering land nearly down to Bonner. The ditch will carry three thousand miner's inches of water and the irrigable area is 995 acres. A bond issue of \$22,000 was sold and the project is nearly completed. The DeSmet Irrigation District elected to come under the jurisdiction of the Montana Irrigation Commission. (For details see elsewhere in this report).

The United States Reclamation Service has put the major part of the Flathead Valley under irrigation. (For details see elsewhere in this report). There are no Carey Act projects in the county. Land that might still be put under irrigation is a tract of three or four thousand acres near the mouth of Clearwater River, three thousand acres on Nine Mile Prairie, ten thousand acres in Missoula Valley, ten thousand acres on the DeSmet bench and eight thousand acres around Frenchtown, making a total of thirty-five thousand acres. This would increase the assessed valuation of the county at the present rate of assessment \$1,000,064.

There are several power development possibilities within the county where power could be developed for pumping projects. Rock Creek and many places along the Blackfoot River have possibilities. There are good many good reservoir sites that might be developed for storing flood waters along the Clearwater River, also, there are two good sites on Rattlesnake Creek.

It is suggested that gauging stations should be established on the following streams, Clearwater River, Big Blackfoot River Near Ovando, Missoula River at Bonner, Rock Creek and Swan River.

MUSSELSHELL AND GOLDEN VALLEY COUNTIES.

These counties will be treated together as they are similar in practically every natural feature. Golden Valley County is one of the newest counties in the state. It was formed mostly from the western end of Musselshell County.

The area of Musselshell County is 1,913 square miles and that of Golden Valley is 1,111 square miles. Ryegate, the county seat of Golden Valley County, is a farming center of 405 people. Lavina and Franklin are two important towns, also supply centers for large surrounding agricultural sections. Roundup, the county seat of Musselshell County is a thriving city of 2,409 people. It has a payroll of almost \$200,000 a month from nearby coal mines, and is a supply point for a large territory. Melstone, a division point on the Milwaukee, lies in the eastern part of the county. Musselshell is an important town between Roundup and Melstone and is surrounded by live agricultural interests.

Both counties are drained by the Musselshell River and its tributaries. The tributaries are in the nature of deep coulees that run a large amount of water every spring, but are practically, if not wholly, dry during the summer months. The general topography is rough and rolling, although large broad benchlands form a considerable part of the agricultural lands. The soil is a clay loam, with a gravel subsoil containing considerable lime—a good soil for grains. However, a heavier clay soil is also prevalent in some sections, especially in eastern Musselshell. The mean annual rainfall is practically the same for both counties and is about 14 inches. The elevation above sea level averages 3,600 feet.

The crops are similar in both counties; wheat the largest grain crop, is supplemented by oats, corn, barley, millet, flax and rye. Alfalfa and

sweet clover, also, produce good crops of hay. Vegetables do very well throughout the territory.

In Musselshell County, the mining of coal is an extensive industry, while oil development is going on in both counties. The state markets of Butte, Great Falls, Billings and the eastern and coast markets are available.

Taken together, the assessed valuation of irrigated land is \$673,899, of non-irrigated land \$15,443,832 and of grazing land \$5,819,972 from the county records at Roundup.

Irrigation dates back to the early settlers in the county along the Musselshell River Valley. Small diversion dams and canals were constructed to divert water from the river on to the low lying bottom lands. No very extensive works were ever constructed. There are at present about 7,500 acres of land irrigated in both counties; about 1,500 acres of this lie along the Musselshell bottom; the rest is situated in the bottom of the tributaries of the river, quite widely scattered throughout both counties. The nature of the flow of the river has made construction of works such as small diversion dams, etc., an extremely hazardous investment. In the spring the river, swollen by the water from the melting snows in the headwaters, is a raging torrent and sweeps out everything in its path. Some attempts to use low lift pumps along the river instead of dams have been tried and have proven fairly successful. These are on a small scale only. In a few instances small storage reservoirs have been created on some of the smaller tributaries by constructing earth dams. Some of these have resulted in failure, but near Lake Mason, a short distance north of Roundup, about a thousand acres have been irrigated in this manner. In most cases where it is possible to construct a dam, there is no land available that could be benefited thereby. The Musselshell river offers the best possibility to reclaim land in both counties, through the development of the Deadman's Basin, a natural reservoir lying just northwest of the town of Barber in the western part of Golden Valley County.

Considerable work of an investigative nature has been done in this vicinity. About twelve miles of diversion canal from the river would be required to form an inlet for the Basin. No dam is required to give a capacity of from 30,000 to 40,000 acre feet, and this capacity can be increased by the construction of dikes along one side giving the reservoir greater depth. A tunnel outlet would have to be constructed and a canal to conduct the water back to the river would be required. This would appear to be a very feasible method of controlling the waters of the Musselshell and furnishing sufficient irrigation water for fifteen to twenty thousand acres of dry land in these two counties. An estimate based upon 1913 prices gave the cost per acre foot of development as ten dollars. The reservoir is being held as an oil prospect, but even the presence of oil should not halt the development of this project as both activities could be carried on together and that section of Montana would benefit materially.

Some of the smaller coulees in the counties offer some chances for small storage dams, from which a few acres could be irrigated. Fish Creek near Ryegate in Golden Valley County has at least one such site a few miles from its mouth. Development of a number of these would bring the total of irrigated acreage to the considerable sum of 20,000 acres. Twenty thousand additional irrigated acres of land would increase the valuation of these counties by about \$1,000,000.

PARK COUNTY.

Park County lies in the southern part of the state adjoining the Yellowstone National Park. It has an area of 2,700 square miles, over half of which is included in National forests. The population is 11,000 of which 6,000 are in Livingston, the county seat. Wilsall and Clyde Park with 500 population each are important towns in Shields valley.

The Gallatin and Bridger mountains lie along the west side of

the county, while the Absarokee and Crazy Mountains are near the east border. Between these mountain borders the Upper Yellowstone Valley and Shields River Valley extending north and south the full length of the county contain practically all of the agricultural land.

The total irrigated area is 100,000 acres, two-thirds of which is watered from Shields river and its many tributaries. The soils of this county are generally fertile and well drained, and produce heavily. Grain, hay, peas and potatoes are the leading crops. Creameries and flour mills are located in the county and all parts of the valley are amply served by railroad facilities for transportation of crops. Livingston is 4,500 feet above sea level, while the average elevation of the irrigable land is 4,700 feet.

At Livingston the mean annual rainfall is 15 inches, about half of which occurs during the growing season. Average annual extremes of temperature run from 22 degrees below zero to 97 degrees above. The average open season between frosts is 117 days.

Irrigated land in this county is assessed at from \$40 to \$100 per acre, dry farm land at \$20 to \$50 per acre and grazing land at \$7.50 to \$20 per acre. The total assessed valuation of the county is about \$36,000,000.

A few thousand acres are irrigated from the Yellowstone river, and in this stream there is a great abundance of water and no question as to water rights but on the many tributaries of the Yellowstone the full supply is utilized and nearly all of these streams have been adjudicated. The amount of water decreed from the several streams are as follows:

Six Mile Creek	31 second feet
Pine Creek	72 second feet
Suce Creek	10 second feet
Eight Mile Creek	42 second feet
Elbow Creek	53 second feet
Deep Creek	83 second feet
Big Creek	64 second feet
Trail Creek	39 second feet

Shields river and its sixty tributaries were covered in one decree entered in 1911, awarding 1,989 second feet of water among some six hundred appropriators. Several small tributaries of the Yellowstone near Livingston are also adjudicated.

In the upper Yellowstone valley, the Armstrong Ditch and the Livingston Ditch are among the largest now constructed. The Armstrong Ditch is owned by the Park Branch Canal Company, and diverts water from the Yellowstone to irrigate 1,200 acres of land lying between Chickory and Brisbin. It has a capacity of 50 second feet, is 10 miles long and loses 50% of its water in seepage. The Livingston Ditch, owned by the Yellowstone Valley Irrigating Company, is 12 miles long, with a capacity of 88 second feet, and irrigates 2,000 acres of land.

In Shields Valley the principal canals are Clyde Park Canal, irrigating 1,500 acres, Lower Shields River Canal, with 2,500 acres and Jordan and Robinson Ditch, watering about 7,000 acres. But the great bulk of the irrigation both in Shields Valley and elsewhere in the county is done by small private or partnership ditches.

For the further extension of irrigation, water supply is available from the Yellowstone by direct flow, and from many smaller streams by storage of the flood waters.

The upper Yellowstone Irrigation District was created Sept. 25, 1920, to irrigate 3,680 acres between Chickory and Brisbin at a cost of \$20 per acre. The main canal is to be 10 miles long, diverting from Yellowstone river. Harry S. Smith of Livingston is Secretary of the District.

A project has been surveyed to divert the Yellowstone River by a dam in Yankee Jim Canyon near Sphinx, to irrigate 20,000 acres in

Paradise valley. This project is now held up pending the outcome of the campaign now under way to control the flood waters of Yellowstone Lake. If storage privileges on Yellowstone Lake are secured, it is also proposed to enlarge and extend the present Livingston Ditch to add another 20,000 acres in this county.

In Shields Valley, 10 miles above Wilsall, the Kisner and Hardy dam is now being built at a cost of \$50,000 to irrigate 2,000 acres of land.

It is also proposed to irrigate about 20,000 acres in the lower Shields valley by constructing a dam on Brackett Creek. Storage sites are also available on the headwaters of Flathead, Cottonwood, Rock and Elk Creeks, which should add about 10,000 acres more to the irrigated area in this county.

Stream gaugings should be maintained on Brackett, Cottonwood and Rock Creeks, in order to determine the water available for storage.

PHILLIPS COUNTY.

Phillips County is one of the northern counties of the state bordering on Canada. It lies between Blaine County on the west and Valley County on the east and is north of Fergus and Garfield counties. The Missouri River defines its south boundary. Its county seat, Malta, a town of 1,427 people is centrally located on the Great Northern railway. Dodson, a town of 365 people, in the extreme west, and Saco, 425 people, in the extreme east, are important distributing centers for their respective territories. Both are on the Great Northern railway.

The area of the county is 5,266 square miles. The average rainfall is 14.13 inches. The average elevation above sea level is 2,400 feet. The county is in the Missouri and Milk River drainage area. The Milk River flows easterly through the center. The general topography is rolling prairie lands, but is rough and choppy in the southern part. The soil generally is of sandy loam and clay loam with some gumbo south of the Milk River. The chief crops are wheat, oats, flax, corn, alfalfa and vegetables. Stock raising is also an important industry in addition to farming. The Great Northern main line crosses from east to west following the Milk River Valley. The markets of St. Paul, Minneapolis and Great Falls take most of the production. The Theodore Roosevelt Memorial Highway follows the Great Northern route and numerous county roads branching from this one give the residents good highway facilities.

The assessor has listed 11,916 acres of irrigated land at a valuation of \$588,650; 306,179 acres of irrigated agricultural land at \$5,644,326, and 643,013 acres of grazing land at \$4,623,945. Exclusive of railroads, telephone lines, etc., the total valuation of the county is \$19,352,229.

The Reclamation Service is doing the most in developing irrigation in the county. As part of the Milk River project about 100,000 acres along the Milk River will be irrigated. A diversion dam in that stream at Dodson and a north and south canal paralleling the river are the salient features. About 12,000 acres are now being irrigated from that source.

Beaver Creek, flowing into the Milk River from the south, has furnished water for irrigation along its bottom lands for several years. It is an adjudicated stream, the amount decreed being 8,187 miner's inches. The water is diverted directly upon the lands from the natural flow.

About 10,000 acres of irrigable land in the county can be developed through construction of storage reservoirs. Phillips County thus has approximately 100,000 acres of irrigable land which when developed will increase in value, according to present differences between dry and irrigated land, at least \$30 per acre, or a total increased valuation to the county of \$3,000,000.

PONDERA COUNTY.

This county is located in northwestern Montana, with the Continental Divide forming its western boundary. It has an area of 2,369 square miles, and a population of 5,741, of which 1,000 are in Conrad, the county seat. Valier with 600 people is another important town.

Most of the county is composed of rolling bench lands while the western part is steep wooded mountains, 122,000 acres of which are included in National forests. Most of the county is tillable and the land lies well for irrigation. The altitude at Conrad is 3,500 feet, while the average elevation of the agricultural land is about 4,000 feet.

The mean annual rainfall is about 12 inches and the average length of growing season is about 125 days. The soil is a deep loam of great fertility and crop yields are heavy. Grain, alfalfa and potatoes are the chief products. The Great Northern railway through the east end of the county with a branch line from Conrad to Valier, furnishes transportation for most of the county.

Land values range from \$50 to \$125 per acre for irrigated land and from \$15 to \$35 per acre for dry farm land. The total assessed valuation of the county is \$24,563,000.

About 120,000 acres are irrigated in the county, 80,000 of which are in the Valier Carey Act project, described elsewhere in this report. The other irrigated lands of the county are mostly in small units along the streams of the county.

Practically all of the direct flow of the streams is now utilized and the Carey Act project depends largely upon storage in two large reservoirs. A still further irrigation development is possible in this county and feasible reservoir sites are available.

POWDER RIVER COUNTY.

Powder River County is located in the southeastern part of Montana. Custer County forms its northern boundary, Carter its eastern boundary, Wyoming its southern boundary and Rosebud its western boundary. Its area is 4,181 square miles. Broadus is the county seat. It is a town of 363 people and situated in the central part. The northern and eastern parts of the county are rolling prairie land. In the other sections it is rougher with numerous coulees and small hills. The county lies in the Yellowstone River drainage area. The Powder River is the chief stream, rising in Wyoming and flowing northward. Otter Creek flows northward from the western part of the county. The soil is a sandy loam and sandy clay loam. The county is at an average elevation above sea level of 3,000 feet. The normal annual precipitation is about 13 inches. The growing season is 126 days.

Stock raising and dry land farming are the chief industries. Alfalfa corn and wheat are the main crops. Miles City, St. Paul and Chicago are the chief markets. The county has no railroads. The Northern Pacific and the Milwaukee at Miles City serve the northern part of the county, and the Burlington in Wyoming serves the southern part. There is a good highway system throughout and daily stage service between Miles City and Broadus.

The non-irrigated lands of the county are assessed by the county assessor at \$2,558,196; the grazing lands are assessed at \$2,775,181. The total assessed valuation of the county is \$9,892,657.

Irrigation is only practiced along the bottom lands of the streams where the summer flow furnishes a sufficient supply. Most of it is along the Powder River. There are several thousands of acres of irrigable lands in the county, but no data regarding the amount of run-off of the streams, have ever been accumulated and the feasibility of irrigating is doubtful. Gauging stations should be placed on Powder River, Mizpah River and Otter Creek. With the addition of more irrigated land, Powder River will become one of the leading counties in eastern Montana.

POWELL COUNTY.

Powell County is situated in central western Montana. It lies in the upper drainage area of the Clark's Fork of the Columbia. Its area is 2,549 square miles. Deer Lodge in the south is the county seat and a town of 3,780 people. The county is largely mountainous except for bench lands in the central and southern portions. The chief streams are the Deer Lodge, Little Blackfoot and Big Blackfoot rivers. The soil is a clay loam, dark in color with a gravel subsoil. The altitude of the agricultural area varies from 4,500 to 5,000 feet above sea level. The mean annual rainfall is about 14 inches. The growing season is not very long and the chief crops are alfalfa and wild hay. However, wheat, oats and barley are also grown extensively. Stock raising, lumbering and dairying are important industries. Butte, Anaconda and Missoula are the chief markets. The N. P. and Milwaukee have parallel tracks in the southern part of the county. Good highways are found throughout.

The county assessor has the agricultural lands of all classes assessed at \$7,935,003 and a total assessed valuation of the county fixed at \$17,371,679, exclusive of railroads and telegraph systems.

Irrigation has been practiced for a good many years along the Clark's Fork of the Columbia. No companies formed for irrigation exclusively have been formed. One irrigation district is pending formation at the present time. It was the first to come under the jurisdiction of the Montana Irrigation Commission. A more complete outline of this project is carried in another part of this report.

In addition there are several thousand of irrigable areas in the county scattered in all parts. The short growing season in the county will have a tendency to delay much development of this sort, however.

PRAIRIE COUNTY.

Prairie County is located in the eastern part of the state. It is crossed by the Yellowstone River Valley. The balance of the county is rolling prairie land. The only land susceptible of irrigation is a small area along the river bottom. The main line of both the Chicago, Milwaukee and St. Paul and the Northern Pacific railways crosses through the county. The area of the county is 1,685 square miles. Terry with a population of 794 is the county seat. The population of the county is 3,684. The growing season averages from 104 to 128 days. The mean annual temperature and precipitation are about the same as Custer County. The elevation of the river valley ranges from 2,100 to 2,300 feet. The total assessed valuation of the county is \$7,519,375.

The only irrigation that is being done in the county is a small area along Powder River. Water is pumped out of the river to cover about sixty acres. There are perhaps three hundred acres scattered over the county in small patches which are being irrigated from small reservoirs in the coulees. In several places flood waters are diverted onto the land in the early spring. The land in this way is soaked up before the growing season begins. There are no gauging stations within the county nor have any water rights been adjudicated.

Work is now being done for the creation of a district to irrigate about thirty thousand acres around Terry. It is proposed to divert water out of the Yellowstone River near Miles City and carry it by gravity. Also work was done this summer on the creation of Cedar Creek Irrigation District, which proposes pumping water out of Yellowstone River to cover some 10,850 acres on the north side of the river just below Terry. Three lifts were proposed, 30, 50 and 150 feet.

So far there have been no irrigation districts filed within the county. Eventually there will be approximately 52,000 acres that will be irrigated along the valley. At the present rate of assessment this will increase the county's assessed valuation by a million dollars. Preliminary work is being done on the development of a power site at

Buffalo Rapids. It is proposed to furnish electric current along the river for pumping. It is recommended that a stream gauging station be placed on Powder River.

RAVALLI COUNTY.

Ravalli County is located in the southwestern part of the state. It is bounded on both the east and west by high mountains. The Bitter Root Valley occupies the heart of the county. The area is 2,391 square miles. Hamilton, with a population of 1,700, is the county seat. The population of the county is 10,098. Other towns of importance are Stevensville, 744, and Darby, 325. The agricultural land in the county is along the Bitter Root Valley. The soil is a good quality of sandy loam. The mean annual precipitation is 11.25; the mean annual temperature is 41.2. The growing season averages from 125 to 130 days. The elevation of the valley varies from 3,300 to 3,600 feet. A branch line of the Northern Pacific railroad runs from Missoula to Darby.

From the county assessor's records, there are 14,489 acres of first class farming land, 61,252 acres of second class farming land, 76,259 acres of third class farming land, 142,219 acres of grazing and 106,569 acres of timber land. The total assessed valuation of the county is \$26,152,046.

The first irrigation ever done in the state was in the Bitter Root Valley when Father DeSmet planted a small patch of grain at St. Mary's Mission in 1841.

The stream gauging stations located in the county are the Bitter Root River near Como, the Bitter Root river near Grantsdale and the East Fork near Darby and the West Fork near Darby. The irrigation districts which have been formed and are in operation in the county are Canyon Creek Irrigation District, established in July, 1909. They diverted water out of Canyon Creek. There are approximately 2,200 acres in the project. Canyon Creek Lake has been reservoired. Their assessment for 1920 to take care of the maintenance cost, interest on the bonds and the sinking fund was \$1.25 per acre.

Blodgett Creek Irrigation District was organized October, 1910, and they issued bonds for \$25,000. The district has 19,110 acres under irrigation. They purchased the rights of the Blodgett Creek Reservoir Company and completed a reservoir at the head of the creek. Their assessment for 1920 to take care of the maintenance cost, interest on the bonds and the sinking fund was \$1.25 per acre.

Mill Creek Irrigation District was established in June, 1910, and the bond issue was for \$40,000. A reservoir has been built at the head of Mill Creek and water is diverted out for irrigation some distance below the reservoir. There are 2,224 acres under irrigation. The assessment for 1920 to pay for the maintenance, interest and sinking fund is \$1.25 per acre.

Charles Irrigation District was established in June, 1918. Water is diverted from Lost Horse Creek to irrigate 847 acres around Charles Heights. The assessment for 1920 to pay for the maintenance cost, interest on the bonds and sinking fund was \$1 per acre.

Sunset Irrigation District, established in November, 1917, floated a bond issue of \$20,000. The water is diverted from Burnt Fork Creek to irrigate land locally known as the south bench. There are 3,025 acres under irrigation. The assessment this year to cover the maintenance, interest on the bonds and sinking fund was \$1 per acre.

The Bitter Root Valley Irrigation Company built a reservoir at Lake Como on the west side of the Bitter Root River and diverted water across the valley through a syphon and down along the bench lands on the east side of the valley as far as Eight Mile Creek. The canal is some seventy miles long and proposed the irrigation of forty thousand acres. Several large syphons and flumes were built as part of the system. This canal has been poorly managed and is not a suc-

cess. The company has recently been re-organized and called the Ravalli Water Company. An application has been filed to come under the jurisdiction of the Public Service Commission.

The Marcus Daly estate has also constructed several large ditches out of the Bitter Root River to irrigate lands extending from Hamilton to Corvallis. The lands from Corvallis to Stevensville are irrigated from Supply Ditch, Union Ditch, Web Foot Ditch and Surprise Ditch.

There are no Carey Act or Reclamation projects within the county. Some years ago a canal line was surveyed from Rock Creek in Granite county over the summit and into the Bitter Root Valley, near the head of Three Mile Creek. It was proposed to irrigate the bench lands between Burnt Fork Creek and Eight Mile Creek and also to develop power for the operation of an electric line through the valley. This scheme was never developed, although perhaps feasible.

The irrigation possibilities of the valley are pretty well developed. The water rights in most of the streams have been adjudicated. Throughout the valley there are perhaps ten thousand acres of land that could still be under irrigation. It is recommended that a gauging station be located on Rock Creek near Lake Como.

RICHLAND COUNTY.

Richland County lies in the eastern part of the state bordering on North Dakota on the east; Roosevelt County and the Missouri River form the northern boundary; McCone County, the west, and Dawson and Wibaux counties the south. The area is 1,900 square miles. Sidney, located in the western end of the county, is the county seat and a town of 1,400 people. It is the junction of the Great Northern and Northern Pacific railways and is in the heart of the lower Yellowstone Irrigation project. Fairview, about ten miles north of Sidney on the Dakota line, is the second town. Lambert, having a population of 287, is in the southwestern part of the county on the Great Northern and is the distributing center for a large dry farming territory.

The county is well drained by the Yellowstone River and its tributaries through the southeastern section, and by the Missouri River and its tributaries on the north. The general topography is rolling with large, broad, level stretches along the west side of the Yellowstone. Along the Missouri River numerous coulees make the surface rough, but it is a very good stock grazing country. The soils are of the chocolate loam and sandy loam type. Some areas of heavy clay loam are also encountered. The mean annual rainfall of the county is 15.36 inches. The agricultural areas lie between 1,900 and 2,500 feet above sea level. The important industry is agriculture. The chief crops in the dry areas are wheat, flax, corn and oats. Alfalfa, sugar beets, vegetables and some grain are extensively grown on the irrigated areas. Stock and dairy products are a big source of income also.

The county is served by branch lines of both the Great Northern and Northern Pacific railways. The Twin Cities market and the Billings market are the most available for the county. The highways of the county are kept in good shape. There is no trans-continental highway. Ferries, instead of bridges, are used to cross the Missouri and Yellowstone rivers. The irrigated land of the county is assessed at \$1,315,058; the non-irrigated and grazing land is assessed at \$13,565,679; the total assessed valuation of the county is \$22,401,926.

Early irrigation was practiced along the lowest levels of the Yellowstone bottom, but with no great success. High water ditches were the type in general use and wild hay was the main crop. Few attempts were made elsewhere to irrigate. A gauging station on the Yellowstone at Intake in Dawson County gives an annual minimum flow at that point of 8,900,000 acre feet. The largest amount yet diverted by the Reclamation Project has been slightly more than 60,000 acre

feet. The balance is allowed to flow from the state. Twenty thousand acres are irrigated along the Yellowstone River by the Reclamation service canal. The Lower Yellowstone Reclamation project furnishes the bulk of irrigated land to Richland County. A more detailed discussion of this subject is carried in another section of this report. There are no irrigation districts in operation in the county. Several individuals have small tracts irrigated along the river on the east side. One of these south of Sidney eleven miles working successfully lifts water from the Yellowstone to the east bank. The actual cost of the project and the maintenance charge were not available due to lack of any records. The area irrigated is about 500 acres. The chief crop is alfalfa. The power used is coal, the local fields of lignite being accessible.

Another area of 700 acres on the east side of the river was once under irrigation by pumping. The lift was 25 feet and the power was steam developed by lignite coal. This project is to be revived. Just across the river from Sidney and a little southeast is a large tract of very good bench land. About 2,500 acres of this can be irrigated by utilizing the spring flood waters from a coulee at the upper end of the area. An examination of the proposed project is now being conducted with a view of ascertaining an estimate of the cost. From observation made heretofore sufficient water for 2,500 acres is practically assured. Another tract of land between two and three thousand acres in extent lies adjacent to the river on the east side and about four miles from the town of Fairview. This would have to be a pumping installation with a lift of not more than 25 feet. A small gas outfit now installed is successfully irrigating about 100 acres there. A feature of the larger project would be an opportunity to purchase electric power from the Jennison Light and Power Company of Fairview. Along Charley Creek in the north end of the county a storage dam was constructed ten years ago. The cost is not accurately known. About 200 acres are under water along the creek bottom and the system is working successfully.

Along the Missouri River on the south bank a pumping project is now under construction. It consists of 800 acres all under a maximum lift of 25 feet. The necessary canals are now practically finished and it is planned to install the machinery in time to irrigate during the 1921 season. Three miles of main canal and three miles of laterals constitute the distributing system. The power will be developed by steam engines burning lignite coal found adjacent to the project. The complete cost is not available. Redwater Creek forms a source for a large quantity of storage water that could be used on lands adjacent to the Missouri River. There are about 10,000 acres lying along the river that are irrigable from this source.

Through the utilization of the main canal of the Lower Yellowstone Reclamation Project a considerably additional area of land in the county will be irrigated. Water can be purchased from the big project at a cost of fifty cents per acre foot. The additional acreage will be irrigated by means of pumps to raise the water to land above and adjacent to the large canal.

In the eastern and northern parts of the county, little further irrigation is contemplated. There are no streams that flow a sufficient amount in the irrigating season to make direct diversions feasible. Lack of suitable storage facilities at reasonable costs makes storage reservoirs not feasible. In all, the future development of irrigation in Richland County allows for an increase of the present irrigated acreage by 25,000 acres. This at the average assessed price per acre of sixty dollars means an increase in valuation to the county of approximately three-quarters of a million dollars. Redwater Creek holds possibilities for storage works. A gauging station is very necessary at this stream.

ROSEBUD COUNTY.

Rosebud County in southeastern Montana contains 5,260 square miles. The topography is generally rolling with a wide valley along the Yellowstone River. The soil is a chocolate loam in the low lands and a sandy loam on the benches. Forsyth is the county seat. Its population is 1,838. Rosebud, 400 people, and Hathaway, 200 people, are important towns along the river.

The Yellowstone and Tongue rivers drain the county. The former flows easterly through the center and the latter flows northeasterly through the southern part. Rosebud and Arnell's creeks empty into the Yellowstone from the south. The Northern Pacific railroad follows the Yellowstone. The Milwaukee railroad enters the county from the east on the north side of the Yellowstone and swings northwest at Forsyth. The chief markets are Billings, Butte, Miles City, Great Falls, St. Paul and Minneapolis. The average rainfall is 13.5 inches. The chief crops are wheat, corn, oats, barley, rye, alfalfa, sugar beets and vegetables. Stock raising is an important industry. The Yellowstone trail, following the Yellowstone River, is being highly improved. Other roads throughout the county are in good shape. The average elevation of agricultural areas is 2,400 feet. The assessor's rolls give the assessed valuation of irrigated lands at \$1,234,160, of non-irrigated lands at \$6,960,651 and of grazing lands at \$6,151,425.

The early irrigation in the county was done along the Yellowstone River bottoms and in Tongue River bottoms, on the Tongue River and on Rosebud Creek. Gravity systems, diverting directly from the rivers, were employed. Along the Yellowstone the constantly changing channel of the river caused the abandonment of many of these or their enlargement and location farther back from the river by means of heavy cuts, or pumping installations. At present there are under irrigation along the Yellowstone approximately 20,000 acres, along the Tongue River about 7,000 acres and in Rosebud and Arnell's creeks about 7,000 acres. However, in the latter two creeks, the irrigation is only in the spring during high water, or by sub-irrigation during the summer months, as these streams flow very little water during the growing season. There are several pumping or gravity irrigation systems in operation at present along the Yellowstone on both sides of the river.

The Hammond Irrigation Company was organized in 1912 and incorporated for \$50,000, divided into 5,000 shares at \$10 per share. A share entitled the owner to water for one acre. The land is on the north side of the river, the intake being opposite Howard on the Northern Pacific and the canal extending east to Forsyth being about 10 miles in length. At the time it was constructed many temporary structures were built and as a result the project was never wholly a success because of a high maintenance cost; but water has always been delivered and good crops have always been grown. In 1920 a district was organized under the district court to include the same land, for the purpose of making permanent improvements. The actual construction will be carried on, on borrowed capital until the bonds of the district can be sold.

The Carterville Irrigation District was organized in 1909. It is a gravity system taking water from a slough of the Yellowstone River on the north side of the river five miles northeast of Forsyth. The canal parallels the river and is about 25 miles long. The area in the district embraces a strip of land from Forsyth to Thurlow on the Milwaukee and varies from one-half to one and one-half miles in width. The Milwaukee railroad traverses the entire district. The acreage irrigated totals 12,600 acres and the chief crops are corn, grains, alfalfa and root crops. No beets are grown extensively as the Billings market is not readily accessible from the north side of the river. Bonds sold amounted to \$360,000 or \$30 per acre. The project is in successful use.

The Yellowstone Irrigation District lies partly in Rosebud County and partly in Treasure County. It was organized in 1909 and at that

time took over the Sanders Cooperative Ditch Company and enlarged and extended that company's holdings. It is a gravity system and the intake is located just west of Hysham on the south side of the Yellowstone. The canal then skirts the foothills east of Hysham and continues easterly to Arnell's Creek west of Forsyth. It is 29 miles in length and embraces in all about 10,000 acres, the area being a strip from one-half to two miles wide between the river and the foothills to the south. The district first appropriated water on the basis of two-thirds of a miner's inch to the acre of land. The canal is 24 feet on the bottom at its head and has good, permanent structures throughout. A syphon nearly a half mile in length paralleling the Northern Pacific railroad is one of the features of the project. It is of the wood-pipe type and has proved very satisfactory. The chief crops are sugar beets and alfalfa. The Northern Pacific railroad traverses the district, and the Great Western Sugar Company is cooperating with the Federal and County governments in constructing a first class gravel highway through the area. Two hundred and fifty thousand dollars of bonds were floated first and the project constructed. Since then the need of drainage works, and more substantial structures necessitated a further issue of \$200,000 of bonds. This was used in headgate improvements, construction of a turtle back dam in the river to insure the full needed diversion and to build about four miles of drains. Some of the drains installed were of tile, the district having its own tile making machinery, but there are also about two miles of open drain now giving very good service. Further drainage is considered necessary, but no serious difficulty is expected from this source. In all, the project will cost about \$45 an acre. It is being successfully handled.

There are two more irrigation districts now organized under the district court, but no construction work has as yet been started. The first, the Highland Park Irrigation District, is a pumping system and will water a high bench just east of Forsyth and extending east south of the Yellowstone River. A lift of 220 feet is necessary to supply water from the river which is the contemplated source. The type of power has not been definitely decided upon and the district may decide to await further development of hydroelectric power on the river before construction. The alternative is the native coal found in the vicinity which may be utilized through gas producing engines. About 5,000 acres will be reclaimed and the main canal will be ten miles long. The soil is a sandy loam and the topography is very favorable for irrigation. A high maintenance and pumping charge is probable on account of the very high lift. The second, the Hathaway Bottom District, is a contemplated pumping project in the eastern end of the county near the town of Hathaway and extending into Custer County. It will reclaim 3,000 acres of fine bottom land with a forty foot lift. Unsettling of the bond market has delayed organization and construction of this work.

In addition there are small acreages just above the canals of the present districts totaling 2,500 acres that can be reached by pumping from these canals a height not to exceed 25 feet, and it is expected that this land will ultimately be irrigated. It is estimated that there are feasible of irrigation along the river in this county 10,000 acres of good land. The numerous creeks and coulees of the county offer opportunities for small storage reservoirs through the construction of dams. Porcupine Creek, which empties into the river from the north, is capable of supply water to 5,000 acres by construction of numerous dams, although the cost in some cases will probably delay their construction for several years. Altogether about 25,000 acres of land in the county exclusive of that along the river, can be irrigated through proper handling of floodwaters of the streams and water courses of Rosebud County. In all about 35,000 acres of land now dry and worth from \$15 to \$30

an acre would under irrigation increase in value at least \$30 an acre, thus increasing the county valuation in real estate alone by a million dollars.

ROOSEVELT COUNTY.

Roosevelt County in the northeastern part of Montana with North Dakota on its east and the Missouri river on its south, has great possibilities for irrigation. It has 2,355 square miles of territory located at an altitude of 2,000 feet above sea level and gets an average of 13.5 inches of rainfall per annum.

Mondak, a town of 203 people, Culbertson with 347 people, Bainville with 396 people, Froid with 410 people, Wolf Point with 2,098 people and Poplar with 1,192 people are the important towns. Stock raising and farming are the important industries; grains, hay and vegetables are grown successfully. The main line of the Great Northern railway and a branch north from Bainville furnish good rail transportation. The chief markets are Great Falls, St. Paul and Minneapolis. The Theodore Roosevelt Highway follows the Great Northern main line.

The county assessor has \$2,000 of irrigated land on his books, \$4,883,738 of non-irrigated land, and \$1,210,524 of grazing land. The total assessed valuation, excluding railroads, telephone and telegraph lines, is \$13,689,363.

The Fort Peck Indian Reservation lies partly in the county and the Fort Peck Indian Reclamation Project is developing 94,000 acres of irrigated land of that area. A fuller discussion of this project is found in another section of this report.

Since the Poplar River, which flows south through the county, will be utilized in full by the Federal project, private irrigation along it is impossible. The Big Muddy Creek is also appropriated by the Reclamation Service, but several tributaries on its east bank will develop storage for considerable irrigation. The largest field for irrigation lies in the Missouri bottom from the mouth of the Big Muddy to Mondak. A strip of land averaging a mile wide and 25 miles long is largely irrigable here. The soil is a clay loam and quite fertile. This area can be irrigated by a gravity system from the river including it all in a district, or by a series of small pumping plants. A pumping installation to irrigate 60 acres will be built in 1921 a few miles west of Mondak. Twelve thousand acres are irrigable along the river.

A small amount of private development has been done recently on some of the coulees in the eastern part of the county. Five thousand acres can be irrigated by utilizing the flood waters of these channels. A recently completed concrete weir on Little Muddy in Township 28 North Range 59 East furnishes storage for 150 acres.

In all, Roosevelt County has 111,000 acres of irrigable land. The increase in assessed valuation of about forty dollars an acre will total \$4,440,000. Roosevelt County bids fair to rank as one of the greatest producers in the state.

SANDERS COUNTY.

Sanders County is located in the extreme western part of the state on the Pacific slope of the Rocky Mountains. The Clark's Fork of the Columbia flows lengthwise through the county and a narrow strip of agricultural land lies along the river valley. Camas Prairie is in the eastern part of the county. Outside of these areas the balance of the county is mountainous and covered with timber. The area of the county is 2,837 square miles. Thompson Falls has a population of 503 and is the county seat. The next largest town is Plains with a population of 452. The population of the entire county is 3,949.

The soil along the river valley is generally a rich sandy loam; along the Camas Prairie it is a mixture of clay and sandy loam. The growing season averages from 110 to 130 days. The mean annual temperature is 45.2. The elevation of the farming area ranges from

2,400 to 3,000 feet above sea level. The chief crops are hay, grain and stock raising. The main line of the Northern Pacific railroad crosses through the entire length of the county.

From the county assessor's records there are 2,395 acres of irrigable land assessed at \$210,050, 23,777 acres of non-irrigated land assessed \$1,029,206, 204,823 acres of grazing land assessed at \$1,231,651 and 169,979 acres of timber land assessed at \$2,887,349, making a total assessed valuation of the county of \$7,115,745.

From the United States census reports there are 25,363 acres that will be irrigated by works either under construction or completed; 8,022 acres are susceptible of irrigation from works constructed and 5,749 acres are actually being irrigated. There are 2,110 acres either irrigated or susceptible of irrigation that are available for settlement.

Streams which are being gauged or have been gauged in the past are Clark's Fork near Plains, Little Bitter Root River near Hubbard, Thompson River eight miles east of Thompson Falls and Prospect Creek near Thompson Falls. Streams which have been adjudicated in the courts are Squaw Creek and Lynch Creek; the east fork of Clark's Creek is now in court.

The Clark's Fork River flowing out of the county and into Idaho is one of the largest streams in the state. Very little of its water is used for irrigation. The records show that 12,080,000 acre feet of water flow out of this county per year. At a duty of three acre feet, this would irrigate 4,027,000 acres.

There are no irrigation districts filed in the county. The United States Reclamation Service has under irrigation a part of Camas Prairie and the Little Bitter Root Valley. (See data elsewhere in this report). The largest company in the county is the Blackfoot Land and Development Company. They divert water out of Swamp Creek; 3,000 acres are irrigable under the ditches. This project is not yet completed. There are many small areas along the river which could be profitably irrigated by pumping. Several years ago the ditch line was surveyed from Thompson River across the Divide into Camas Prairie. Nothing more was ever done with this scheme.

Outside of the area which the United States Reclamation Service contemplates irrigating, there are about 10,000 acres along the river valley that are susceptible of irrigation either by gravity or pumping. At the present rate of assessment this would increase the county's assessed valuation by \$880,000. There are many possibilities along the Clark's Fork River for power development. One of the largest power plants in Montana belonging to the Montana Power Company is located at Thompson Falls. Dog Lake, located between Plains and Camas Prairie, offers a possible reservoir site for irrigation on Camas Prairie.

It is recommended that a gauging station be located on the Little Thompson River.

SHERIDAN COUNTY.

Sheridan County, the mother county of Daniels, lies in the extreme northeastern corner of Montana. Canada forms the northern boundary, Daniels the western, Roosevelt the southern and North Dakota the eastern. The topography is rolling prairie lands with a wide valley extending along the Big Muddy Creek bottom. The area is 1,758 square miles. The soil on the bench lands is a sandy loam and in the valley a clay or chocolate loam. The drainage is all into the Big Muddy, which flows south through the central portion. During the summer months its flow is slight and its waters are full of alkali and sediment.

Plentywood, the county seat and largest town, is centrally located on the Great Northern branch to Scobey. It has a population of 888. Antelope and Medicine Lake, two towns on the Great Northern to the south of Plentywood, have populations of 285 and 292, respectively. Outlook, located in the northern part on the M. St. P. & S. Ste. M. Ry. Co., has 285 people and Westby, in the extreme northeastern part, has 253 people.

The average elevation of the county is 2,100 feet above sea level and the average precipitation is about 12 inches. The chief industries are farming and stock raising. Flax, wheat, oats, rye, barley, corn and hay are the important products.

The county has two railroad lines. The Scobey branch of the Great Northern railway leaves the main line at Bainville in Roosevelt County and runs north to Plentywood, thence west through the central part of the county. A daily passenger train and two daily freight trains give very satisfactory service to this section. The Soo branch enters from North Dakota in the northern part of the county and extends west through the county. The chief markets are St. Paul and Minneapolis. There are no trunk line highways, but the county roads give good service and are being extended each year. Tillable land of the first class is assessed at \$7,427,220, second class at \$3,108,520 and grazing at \$1,808,555. The total assessed valuation of the county is \$28,928,615.

Irrigation has never been practiced extensively in the county. Not to exceed 500 acres are partially irrigated along the Big Muddy, during the period of high water in the spring. The Reclamation Service claims the flow of the Big Muddy and its tributaries on the west. The only areas that could be irrigated are small tracts adjacent to coulees on the east side of the Muddy, where storage dams could be constructed in the coulees. None examined, however, showed promise of feasible development. With a return to cheaper construction costs it is expected some development will be done along this line, although Sheridan County will always be dependent on the outside for the bulk of its irrigated necessities.

SILVER BOW COUNTY.

Silver Bow County is located in the heart of the Rockies in southwestern Montana. The Big Hole River marks its southern boundary. Its area is but 698 square miles. Owing to its average elevation above sea level of over 5,200 feet and the mountainous character of its topography, very little agriculture is carried on. It has a growing season of 108 days and a mean annual precipitation of 13.7 inches. Butte is the county seat with a population of 41,611 people. Centerville, Walkerville and Meaderville are suburbs situated close to Butte. Silver Bow Creek flows westerly through the county, and the Big Hole river drains the southern part. The chief industry of the county is mining. Some agriculture is carried on, however; truck gardening and dairying in the vicinity of Butte and hay raising along the Big Hole. The Great Northern, Northern Pacific, C. M. & St. P., Oregon Short Line and Butte, Anaconda and Pacific railroads all run into Butte, which is the chief market for agricultural products.

The assessed valuation of irrigated land from the assessor's office is \$360,000, of non-irrigated land is \$380,000 and of grazing land is \$559,880.

There are no companies operating exclusively as irrigation companies in the county. Most of the 15,000 acres irrigated lie adjacent to the Big Hole River. The irrigation here is carried on by ranches operating individually or in groups. The main crop raised is hay.

Near Butte are several truck and dairy ranches irrigating but a few acres. Only about 90 acres are irrigated in this manner. Little additional irrigation is possible in the county.

STILLWATER COUNTY.

Stillwater County is located in the southern part of the state and has an area of 1,650 square miles. The total population is about 8,000, of which 900 are in Columbus, the county seat. Absarokee, Park City, and Reedpoint are other important towns.

The Yellowstone river runs from west to east through the middle of the county. The area north of the river is composed mostly of rolling bench lands suitable for dry farming. The Lake Basin, a

famous dry land wheat section is in this part of the county. The south half of the county is composed of river valleys and high benchlands terminating in very high and rugged mountains at the south end of the county. The elevation at Columbus is 3,700 feet, while the average elevation of the cultivated lands is about 4,000 feet.

The mean annual rainfall at Columbus is about 14 inches and the average length of growing season between frosts is 122 days. Grain, hay, sugar beets and honey are the leading crops. The Northern Pacific railway running along the Yellowstone river furnishes ample transportation for the central part of the county, while the Lake Basin branch of the same road furnishes an outlet for crops in the northern part of the county. The southern part of the county is greatly handicapped for lack of transportation and is, therefore, devoted mostly to stock raising.

There are about 40,000 acres of irrigated land in the county and 350,000 acres of non-irrigated agricultural land. Land values range from \$15 to \$35 per acre for dry farm land and \$40 to \$120 per acre for irrigated, depending largely upon nearness to the railroad. The assessed valuation of the county is \$26,000,000.

The soils range from heavy clay in the Lake Basin to light sandy loam on some of the benches. The river valleys have dark loam soils often mixed with gravel and small boulders. Most of the soils are quite fertile, but in many places injurious alkalies appear.

Irrigation has been practiced in this county for 30 years with good results. Most of the irrigation is by small private ditches. About 30,000 acres are irrigated along the river valleys of the Stillwater and its tributaries and 10,000 acres along the Yellowstone river. There is ample water in these streams and no water rights have been decreed.

The Columbus Irrigation District was created in 1919 to irrigate 1,800 acres adjoining the town of Columbus by a 16 mile canal diverting from Yellowstone river. The land has been irrigated since 1910 by water from Stillwater river, carried by pipe across the Yellowstone. This pipe was washed out in the high water of 1918 and the land has since been without water. Construction on the ditch has been under way for the past year and the cost has greatly exceeded the original estimates. Ninety-three thousand dollars of 6 per cent bonds have been sold at 10 per cent discount. The canal is 90 per cent completed and is expected to deliver water for next year's crops. P. H. Helly, of Columbus, is secretary of the district.

Stillwater is one of the best watered counties in the state and has ample opportunities for a much greater extension of irrigation. Fifty thousand acres of good bench land between the Stillwater and Yellowstone are irrigable by a high line canal from the Stillwater. Large tracts east of the Rosebud and Stillwater rivers could also be irrigated at reasonable cost. Some storage may be necessary in connection with these larger projects, but reservoir sites are available for that purpose. It is probable that from 75,000 to 100,000 acres in this county could be irrigated at reasonable cost.

In addition to the above possibilities, it has been proposed to irrigate about 200,000 acres of land in the Lake Basin, with water stored in Yellowstone Lake. This would require a very long and expensive canal and involve serious drainage problems, and its feasibility is yet doubtful. On some of the Yellowstone valley lands, irrigation by pumping is feasible. Several good power sites are found in the south end of the county. Gauging stations should be maintained on Stillwater river and its principal tributaries.

Stream gauging stations should be maintained on Stillwater and Rosebud rivers near Absarokee.

SWEET GRASS COUNTY.

Sweet Grass County lies in southern Montana not far from the Yellowstone Park. It has an area of 1,900 square miles, about 20% of which is included in national forests. Big Timber, with a population

of 1,300, is the county seat. The total population is 5,000 and the assessed valuation over \$20,000,000.

The southern part of the county is occupied by very high mountains with some peaks over 12,000 feet high. The Crazy mountains occupy the northwest corner of the county. The Yellowstone river runs from west to east through the middle of the county. Big Timber, Otter and Sweetgrass creeks, coming in from the north, and Boulder river and Upper and Lower Deer creeks, entering the Yellowstone from the south, furnish the main sources of water supply for the county. The elevation at Big Timber is 4,100 feet and the irrigated areas lie mostly between 4,000 and 4,800 feet elevation.

The soils are generally fertile, though excessive alkali appears in some parts. The mean annual rainfall at Big Timber is about 15 inches and the average open season between frosts is about 120 days. Alfalfa is the principal crop under irrigation, while fairly good grain crops are raised on the bench lands without irrigation. The principal exports from the county are grain, live stock, dairy products and honey. The main line of the Northern Pacific railway furnishes good transportation to the central part of the county. A branch line has been surveyed to Melville, but until that is built the northern end of the county is much handicapped for lack of transportation.

According to the assessment rolls there are in the county 48,000 acres of irrigated land valued at \$54 per acre, 210,000 acres of non-irrigated agricultural land at \$22 per acre, and 443,000 acres of grazing land at \$8 per acre.

Irrigation has been practiced in this county for over 30 years. Gravity systems are used and storage is not necessary except on the Big Timber Carey Act project. Most of the irrigation is by small private ditches.

Water rights on several of the streams have been determined by court adjudication and the amounts so decreed are:

Sweetgrass Creek	484 second feet
Big Timber Creek	677 second feet
North Fork Otter Creek	17 second feet
Duck Creek	98 second feet
Lower Deer Creek	30 second feet
Bridger Creek	11 second feet

On Boulder and Yellowstone rivers there is ample supply and no question of water right.

From Sweetgrass and Big Timber creeks about 25,000 acres are now irrigated, about half of this amount being included in the Glass-Lindsay Carey Act project more fully described elsewhere in this report.

From Boulder river about 20,000 acres are irrigated mostly by small private ditches constructed at low cost. The largest ditch diverting from the Boulder is the Dry Creek canal built in 1900 at a cost of \$25,000. It is 15 miles long with a carrying capacity of 75 second feet and serves 3,000 acres of land lying southeast of Big Timber.

The Greycliff Irrigation District was created in March, 1920, to irrigate 2,000 acres near Greycliff by enlarging and extending the old Bailey Ditch diverting from Boulder river. Estimated cost is \$35 per acre. No bonds have yet been sold and no construction started. F. R. Hickman of Greycliff is Secretary of the District.

Many thousand acres additional can be watered by direct flow from Boulder river. A Carey Act project was at one time started to cover 13,000 acres of this land but was later dropped. A considerable area can also be irrigated from Yellowstone river. The total irrigable acreage that could be developed at reasonable cost is estimated at from 25,000 to 40,000 acres.

TETON COUNTY.

Teton County lies in northwestern Montana, just east of the continental divide. It has an area of 1,650 square miles, one-fourth of which, is included in National forests. The population of the county is 5,900 and that of Choteau, the county seat, is 1,000. The greater portion of the county is composed of broad valleys and rolling bench lands, with an average altitude of 4,000 ft. above sea level, while the western part of the county is covered by steep rugged mountains of 7,000 or 8,000 feet elevation. The soils of the county are mostly quite fertile and the land lies well for irrigation. Teton and Sun Rivers and Willow and Muddy creeks drain the county and furnish the water supply for irrigation.

Grain and alfalfa are the chief crops and three lines of railroad in the county furnish transportation to market. The average assessed valuations are \$12 per acre for grazing land; \$25 for dry farm land, and \$50 per acre for irrigated land. The total assessed valuation of the county is \$27,000,000.

The mean annual rainfall is 15 inches, and the average growing season is about 100 days. About 50,000 acres are now irrigated in the county, and over twice that amount is irrigable. A great increase of irrigation is possible through storage of water and good reservoir sites are available.

Of the irrigated lands in the county, about 3,000 acres near Fairfield are included in the U. S. R. S. Sun River project described elsewhere in this report. Three thousand acres are irrigated on Deep Creek and 1,000 acres on Willow Creek. Three thousand acres are irrigated on the Teton river above Choteau. Northeast of Choteau a large expanse of excellent bench land is irrigated under the Burton, the Farmers, and the Eldorado ditches, All diverting from Teton river. About 40,000 acres are served by these three ditches.

A large Carey Act project was planned several years ago to irrigate 40,000 acres near Brady, being partly in Teton and partly in Pondera county. After construction of the Bynum reservoir the project was dropped. The reservoir rights have now been acquired by the Bynum Irrigation District, which was created in March, 1920, and is now preparing to irrigate other lands near Bynum, amounting to 25,000 acres, besides furnishing water to 5,000 acres near Brady.

Under the U. S. R. S. Sun River project, it is planned to eventually irrigate an additional area of about 70,000 acres northeast of Fairfield; with all the contemplated irrigation completed, this will be one of the best watered counties in the state.

TOOLE COUNTY.

Toole County lies in the northern part of the state adjoining the Canadian Border, bounded west by Glacier County and east by the newly created county of Liberty. The county covers an area of 1,950 square miles.

Shelby is the county seat, with a population of about 500. Other towns are: Sweetgrass, Ethridge, Dunkirk, Devon, and Galata. The population of the county is 4,000.

The county is mostly rolling prairie and bench lands, with some rather high hills in the northeast corner and broken bluffs and bad lands near the western and southern borders. The Marias river runs full length of the county along the south end. Willow Creek with its many tributaries drains the eastern half of the county, while a large part of the west half has no drainage outlet.

The soil is mostly of the clay type so common to Montana. In many of the ravines a gumbo soil is found, strongly impregnated with alkali. Because of the prevalence of alkali in this county, the problem of drainage must be fully considered in connection with any irrigation development.

The mean annual rainfall is about 13 inches, and the average length of growing season is 98 days. Dry farming was quite successful from 1911 to 1916, but since that date, has been almost a complete failure.

The county ranges from 2,800 to 6,800 feet elevation, with an average of 3,500 feet. Dry farm grain is practically the only crop for export. There is practically no irrigated land and no timber land, the total area of the county being about equally divided between grazing and dry farm lands.

The county has two main line railroads providing ample transportation. Wheat is shipped mostly to Minneapolis. A main line highway crosses the county.

The average assessed valuation is \$9 per acre for grazing land and \$15 per acre for plow land. Total assessed valuation of the county is \$18,500,000.

A few ranches along Marias river and in the hills in the northeast corner of the county have done some irrigation on a small scale, and not exceeding a few hundred acres for the entire county.

Marias river is the only stream of any importance in the county. Several intermittent streams, of which Willow Creek is the largest, flow a considerable amount of flood that might be stored for irrigation purposes.

No streams have been adjudicated. Many water appropriations are of record, but since practically no irrigation is done, the appropriations are of little or no consequence.

A few small streams in the north end of the county flow northward into Canada, but the amount of water thus lost is very small.

Several private ditches have diverted water from Marias river for irrigating small areas of bottom lands. About 500 acres have been thus irrigated along Marias river and about half that amount from small streams among the Sweetgrass hills. Some of these ditches have been abandoned and much of the irrigation has been discontinued. The actual acreage properly irrigated at present is negligible.

The Toole County Irrigation District was organized in September, 1919, to irrigate over 200,000 acres of land in this county. Jas. A. Johnson, of Shelby is president of the district. The Gerharz-Jaqueth Engineering Company is doing the engineering. Final surveys and estimates are not yet completed. It is proposed to store the flood waters of Marias river and its tributaries in four reservoirs, having a combined capacity of 276,000 acre feet. The probable cost of the project will be about \$50 per acre.

Stream gaugings should be maintained on Willow creek near Galata.

TREASURE COUNTY.

Treasure County in the heart of the Yellowstone River Valley is in the southeastern part of the state. Rosebud, the mother county, forms its northern and eastern boundaries. Big Horn County lies south of it and Yellowstone County limits it on the west. It is a small county having only 997 square miles of territory. The county seat is located at Hysham. Its population is 260 people. Big Horn is an important trading center in the western end of the county; Sanders is located in the east end.

The general topography is rolling. The valley of the Yellowstone here is broad and smooth, affording opportunity for general agriculture. The drainage is effected by the Yellowstone River which flows from west to east dividing the county almost equally in area. Into it drain the Big Horn River and Sarpy Creek from the south, and Alkali, Pease, Froze to Death, and Stand to Death creeks from the north. The soil is a rich clay loam in the Yellowstone Valley, becoming somewhat lighter in the other parts of the county. The mean annual rainfall is about 13 inches. The average altitude above sea level is 2,600 feet. The chief industry is agriculture, both farming and live stock. Alfalfa, sugar beets, grains and vegetables thrive. Wheat and corn are successfully

grown on the non-irrigated sections. Billings is the chief market for sugar beets and Butte and the eastern cities are markets for other produce.

The Northern Pacific railway follows the river through the territory and taps the largest producing section. Numerous stations provide good shipping facilities. The Yellowstone Highway also traverses the county and is being improved by the State Highway Commission, which will make it an excellent roadway. There is necessity for several bridges across the river to join this road, however. The irrigated land in Treasure County assesses at \$1,227,490. The non-irrigated assesses at \$2,149,830 and the grazing and timber lands at \$1,296,421. The total assessed valuation of the county is \$6,424,821. These records are from the county assessor's files.

Early irrigation was practiced along the lower river bottoms by individual or partnership ditches, generally carrying water during high flood stages. The only crop sought was hay sufficient for the need of stock ranches. Later, came the era of alfalfa, sugar beets and vegetables and these early ditches were improved or taken over by larger companies or districts and enlarged. The Echeta Ditch was one of the early ditches although it was later incorporated and still later taken over by the Rancher Ditch Company. The Rancher Ditch Company was organized in 1904 to irrigate lands lying on the north side of the river north and west of Hysham. The source is the Yellowstone River, the water being conducted by gravity from a point almost opposite the mouth of the Big Horn river to a point north of Hysham. The ditch carries normally 4,600 miner's inches or 115 second feet. The company incorporated for \$20,000, issuing 2,000 shares at \$10 each, of which 1,600 shares were bought and the system installed. Later the balance was disposed of at \$25 a share for more development. The shares are not limited to land owners, and a share of stock calls for one two-thousandth of the total water available. So far there has always been an excess of water for any of the land.

The chief crops are beets and alfalfa. Since the railroad is on the south side of the river, the produce must be hauled across to ship it. Lack of a bridge causes the farmers near Hysham to resort to a ferry, which tends to diminish the amount of beets grown. The system has always given satisfaction and is very successful.

On the same side of the river extending east from Hysham to about north of the town of Sanders is a project known as the North Sanders Irrigation District. It was organized under the district court to take over the North Sanders Cooperative Ditch Company's works and extend and enlarge the same. It is part gravity and part pumping. The gravity canal diverts from the Yellowstone and covers some 3,700 acres. From this canal an installation of two 25 H. P. oil engines pump two lifts, of 11 and 18 feet. Under the 11 foot lift are 800 acres and under the 18 foot lift are 1,100 acres. It is planned to reclaim an additional 200 or 300 acres by pumping from the 18 foot lift canal later on. Altogether there are now irrigable 5,600 acres. The land was bonded for \$100,000 which completed the project although it is intended to float an additional issue of \$10,000 for further development and improvements. The cost was less than \$20 an acre. The chief crops are alfalfa and grains. The season of 1920 was the first real test of the project, and although no data relative to maintenance cost are to be had as yet, it is considered that the annual cost will be low and the project will be very successful.

The Yellowstone Irrigation District which is partly in this county has been treated in the report on Rosebud County. The Box Elder Irrigation District organized in 1919 irrigates 1,485 acres above the canal of the Yellowstone Irrigation District by pumping from that canal. The land lies just east of Hysham about two miles. It was bonded for \$40,000 or at a cost of \$25 an acre. Alfalfa and sugar beets form the main crop. It has proved successful so far and is expected to continue

so. Water is purchased from the Yellowstone Irrigation District at the rate of 50 cents an acre. The Big Horn Tulloc Company built a project near the mouth of the Big Horn River, taking water from that river and irrigating lands near the town of Big Horn. It is a gravity system, but in cases of extreme low water expects to be prepared to pump to its canal, for which contingency it is now installing pumping machinery. It covers 2,000 acres and was installed in 1910 at a cost of \$18 per acre. It has been successful in turning out good crops of beets, alfalfa and grain. The Hysham Irrigation District, organized in 1919, proposed to irrigate some 6,000 acres of bottom land immediately adjacent to Hysham. The source of water is the Yellowstone, from which it will have to be pumped. The canal will be about five miles in length; \$300,000 of bonds have been authorized but have found no market yet. This area, on the Northern Pacific railroad, will be well suited for growing of sugar beets and alfalfa and should prove very successful. This last project completed, very little land that can feasibly be irrigated from the river will remain in Treasure County. There are of course some tracts that are not covered by these large districts. Individual oil engine pumping plants of low lifts in the river bottoms add a considerable acreage to the county's total.

Back from the river on the various streams are opportunities for development of storage reservoirs. About 8,000 acres could be brought under whole or partial irrigation by means of numerous individual dams, thus holding the water that annually goes to waste in the spring. The development of 8,000 additional acres of land in Treasure County would mean an increase to the valuation of at least a quarter of a million dollars, an item that certainly should be considered. In addition, the land would produce that much every year in addition to its present productivity.

Some data regarding the annual flow of the streams in the county are desirable for their fuller development.

VALLEY COUNTY.

Valley County in northeastern Montana is located between Canada on the north and the Missouri River on the south. It has an area of 5,064 square miles. The county seat, Glasgow, has 2,059 people and is located on the Great Northern on the Milk River in the center of the county. Nashua, the second city, has 751 people. It is east of Glasgow and on the Great Northern.

The northern part of Valley County is rolling bench lands. In the southern part, the surface is rougher with numerous draws and coulees. The Missouri and Milk rivers form the drainage. Rock Creek Porcupine and Little Porcupine are the other important water courses. The soil varies from light sandy loam in the north to heavy gumbo in the southern part. The average elevation of the county is 2,200 feet above sea level. It gets an average rainfall per year of 13.25 inches.

Agriculture and stock raising are the chief industries. Glasgow has a large flour mill. The chief markets are St. Paul and Minneapolis and local. The Great Northern traverses the county from east to west following the course of the Milk River and places the markets of St. Paul and Minneapolis and Great Falls within reach of the county.

There are 2,618 acres of irrigated land assessed at \$78,540 on the assessor's rolls. Non-irrigated totals 598,951 acres assessed at \$10,991,636 and 546,765 acres of grazing land is assessed at \$4,374,020. The total for the county exclusive of railroads, etc., is \$27,660,116.

Irrigation on a small scale only has been possible in Valley County. Along Rock Creek in the western end of the county a few direct diversion works were built prior to 1902.

No districts have ever been organized in this county. A company, named the Rock Creek Canal Company, incorporated in 1902 for \$9,600, issuing sixty shares at \$160 per share. Organized as a closed corporation, a fourteen mile canal from Rock Creek was constructed, taking out

of Rock Creek and extending southeast to Vandalia, embracing land lying north of the Milk River. About 2,000 acres are irrigated successfully at present, the chief crop being hay.

A large section of the Milk River Reclamation project lies in Valley County. This section consists of a diversion dam at Vandalia out of the Milk River and a canal on each side of the river. This construction will completely irrigate the Milk River Valley in Valley County. A detailed description of this project will be found in another article of this report.

Over 100,000 acres will ultimately be irrigated in this county at an increased valuation to the county of three million dollars.

WHEATLAND COUNTY.

Wheatland County, in the central part of Montana, lies south of Fergus County, east of Meagher County, north of Sweet Grass County, and has Musselshell County on the east. Its area is 1,436 square miles. Harlowtown, the county seat, is a growing agricultural and railroad city of 1,856 people, centrally located in the county. It is a railroad division point and the eastern point of the Chicago, Milwaukee & St. Paul electrified system. Judith Gap in the northern part of the county has 522 people and is the junction of the Great Northern and Chicago, Milwaukee & St. Paul railways.

The general topography of the county is rolling bench land, with mountains flanking the west and north boundaries. It is drained to the southeast by the Musselshell River and its tributaries. Soil conditions in this county are exceptionally good, changing from a heavy loam to a sandy loam. The mean annual rainfall is 14.21 inches. The agricultural areas vary from 3,500 to 4,800 feet above sea level.

The main crops are grains and alfalfa. Stock raising is a well developed industry in the county, the grazing ranges being plentiful and well watered. The oil industry is taking prominence here and much development work is being carried on. With its railroad facilities, the markets of St. Paul and Minneapolis, Great Falls and Butte are made accessible. There is a well-planned system of highways, and the Park-to-Park roads are well traveled by tourists.

The assessed valuation of the County is \$23,989,656, according to the county assessor's records. The agricultural irrigated land is valued by the assessor at \$740,400; the non-irrigated at \$13,070,954; and the grazing land at \$2,845,306.

The earliest irrigation was practiced in the bottom lands along such streams that gave a sufficient flow through the irrigation season. In most cases the works required consisted only of a canal, with perhaps a diversion dam at its head. The lands along the Musselshell River are the most extensive of the irrigated lands in the county. Approximately 10,000 acres lying along the Musselshell are irrigated which includes the smaller tributaries.

South of Harlowtown on American Fork and Lebo Creeks 3,500 acres are under irrigation. At Harlowtown on the Musselshell River a gauging station has been conducted since 1907. Also in 1907 stations were established on Lebo Creek and American Fork Creek about five miles southeast of Harlowtown. In 1920 stations were established on Careless Creek and on Roberts Creek in the eastern part of the county. Lebo Creek and American Fork Creeks are the only adjudicated streams in the county, the decree giving American Fork users 11,398 miner's inches or 248.8 second feet, and Lebo Creek, 2,172 miner's inches, or 54.3 second feet.

Lebo Lake, south of Harlowtown, has been developed as a reservoir by diverting from this stream and by construction of a dam and outlet works. This work was done by an incorporated company organized in 1903. The company was capitalized at \$25,000, there being 1,000 shares at \$25 each. Three commissioners are elected to handle the company's business. The company is now engaged in raising the dam about eight

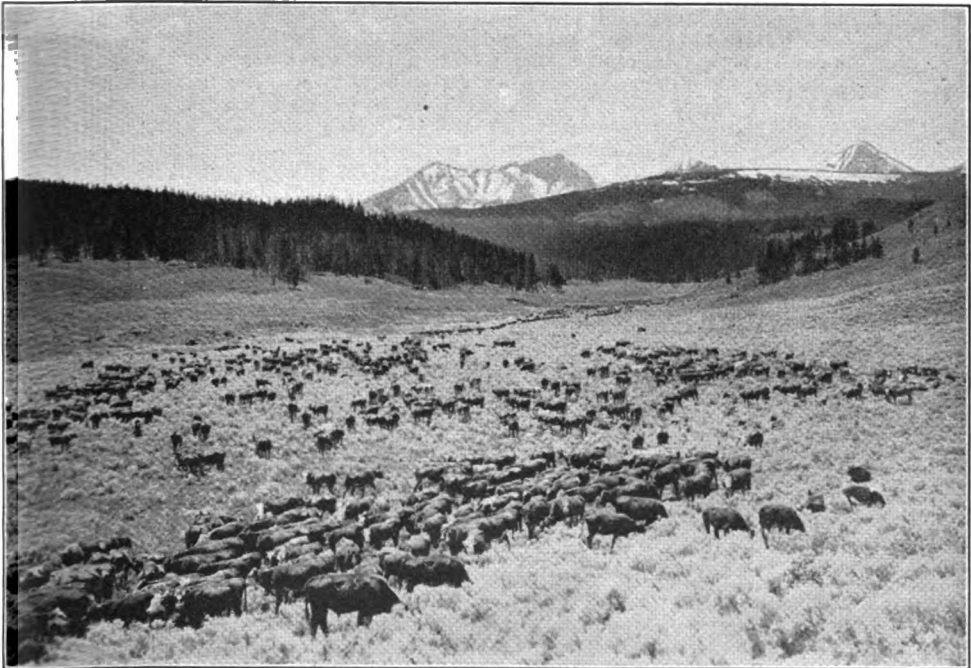
feet to supply an additional acreage of about 2,000 acres. The company furnishes the water supply, the user building his own canals and buying the water used. The project has been successfully handled and has resulted in greatly increased production for that section of the country.

The Harlowton-DuRand Irrigation District, now being handled through the Montana Irrigation Commission, contemplates the irrigation of 16,600 acres. A fuller statement pertaining to this project will be found elsewhere in this report.

The eastern part of the county offers a possibility in bringing considerable acreage under irrigation, the source of water supply to be Roberts Creek and Carless Creek. Some preliminary work in the way of water measurements has been started during 1920. Five or six thousand acres are irrigable in this part. The reservoir sites on these streams are not particularly good. The dams required would be long, though not of very great height.

The land here is high class bench land sloping about 75 feet to the mile. There is a considerable quantity of lime in the subsoil and grain has been raised for several years under dry land conditions with good results. No extensive canal system would be required as the land lies adjacent to the reservoir. Hedgesville, a railroad point on the Great Northern, is about eight miles from the lands.

Wheatland County has 30,000 acres of irrigable land of highest quality. The average difference in valuation between irrigated and non-irrigated lands in the county is \$40. The total increase in value to the county with development of irrigation on its irrigable areas will be \$1,200,000.



The Farmer's Big Assets Are Cattle, Perpetual Snow and a Well-Timbered Watershed

WIBAUX COUNTY.

Wibaux County lies in the extreme east central part of the state. On the north, Richland County forms its boundary; Dawson County lies on the west, Fallon County on the south and the state of North Dakota on the east. The Yellowstone River forms the boundary line between Dawson County in the northeastern part. It is a small county having a total area of 994 square miles. The country for the most part is rolling. There are numerous coulees in parts of the county, making the surface rough, but also giving protection for grazing stock. The main stream, Beaver Creek, traverses the county from the south and flows into North Dakota from the northern part of the county; Cedar Creek, Dry Creek and Cottonwood Creek all flow westerly from the county emptying into the Yellowstone River. Along Beaver Creek is a bottom from one to two miles in width, on which very fertile loam soil is prevalent. The soil throughout is generally a sandy loam of good fertility. The county lies at an elevation of 2,600 feet above sea level and its mean annual rainfall is about 15 inches.

The principal town and county seat is Wibaux, centrally located on the Northern Pacific railroad. It has a population of 611 people. The principal industry is agriculture, both farming and stock raising. Wheat, oats and corn are successfully grown without irrigation in normal seasons. Flax and potatoes are also important crops.

The main line of the Northern Pacific railroad, traversing an east and west course through the middle of the county, places the markets of the state and of east in easy reach of the producers. The people have realized the benefit of good roads and are building up a good system of highways in their county. The Red Trail, a favorite for tourists, follows the railroad, and annually serves a large traffic.

The agricultural land of the county is assessed at \$7,173,123. This is dry land, but includes a very small acreage of partially irrigated land. Irrigation has never been practiced extensively. Several years ago a dam to divert water from Beaver Creek, a few miles north of the city of Wibaux, was utilized to irrigate 150 to 200 acres during the high water period when water was available. However, this was never very successful because of lack of water at the proper time and has fallen into disuse. No irrigation is done with the exception of a flooding on some small tracts in the Beaver Creek bottom during the spring floods. On account of scarcity of reservoir sites, where storage water is available, nothing has been done to develop irrigation. Numerous small dams have been built to form water holes for stock, but none are large enough to store irrigation water. In many of these cases, the dams can be raised to form reservoirs, and other coulees offer similar opportunities. An effort was made to determine an estimate of the number of acres that could be developed into irrigated tracts by this method. It was estimated that not less than 5,000 acres were available in all parts of the county and that this was a very conservative estimate. Lands in the lower Yellowstone Valley, a few miles west, are now being valued at \$150 to \$200. This is an increase over dry land in Wibaux County of \$100 an acre; so that 5,000 acres of irrigable land when irrigated would increase the county's valuation by \$500,000. Measurements of the flow on Beaver Creek should be made immediately, as there are undoubtedly good possibilities for storage on that stream.

YELLOWSTONE COUNTY.

This county lies in south central Montana at an altitude ranging from 3,000 to 4,000 feet. Billings, the county seat, has an elevation of 3,100 feet and a population of 15,000, which is just half the total population of the county. The total area is 2,700 square miles.

Yellowstone river flows lengthwise through the middle of the county and about half the area of the county is composed of valley lands

along this river. The balance is rolling and broken bench lands, used for dry farming and grazing purposes. The valley lands are mostly irrigated and constitute one of the largest and most successful irrigated sections in the state.

The soils are mostly a rather heavy clay silt with insufficient natural drainage and after a few years of irrigation, develop seepage and alkali troubles which must be removed by artificial drainage. When properly drained these lands produce valuable crops.

In this county the winters are very cold, while the summers are hot. The average growing season is 125 days. The mean annual precipitation is 14 inches. Corn, alfalfa and sugar beets are grown with good results. The sugar factory at Billings furnishes local market for the beet crop at good prices. Billings is an important railroad center and the county has excellent transportation facilities.

About 125,000 acres are irrigated in the county and the average value thereof is about \$150 per acre, while the average value of dry farm land is about \$25. The total assessed valuation of the county is \$84,500,000.

Irrigation has been practiced in this county for 40 years, with very satisfactory results, except for the development of seepage troubles, which have necessitated the drainage of a considerable acreage. A much larger area now needs drainage and plans are under way to drain most of the irrigated lands above Billings. Considerable drainage has been done by the U. S. Reclamation Service on the Huntley project below Billings.

The Yellowstone river is the main source of supply for irrigation, though some of the tributaries are also used for a small acreage. On the river no water rights have been adjudicated, as the supply is ample for all needs. A few of the minor streams have been decreed.

The principal canals diverting from Yellowstone river and the acreage served by each are as follows:

Cove Ditch	5,500 acres
Big Ditch	37,500 acres
Billings Ditch (Carey Act Project)	25,000 acres
Canyon Creek Ditch	5,000 acres
Suburban Ditch	2,000 acres
Lockwood Irrigation District	2,500 acres
Coulson Ditch	3,000 acres
Huntley Project (U. S. R. S.)	33,000 acres

The first five of these ditches irrigate lands on the north side of the river and the last three lands on the south side. Cove ditch has its diversion above Park City in Stillwater County, but most of the lands irrigated are in Yellowstone.

The Big Ditch is 60 miles long and has been in operation with good success for over 20 years. The Canyon Creek ditch was built 35 years ago. The Suburban Ditch is also an old one and irrigates lands adjoining the city of Billings.

Lockwood Irrigation District is a pumping project operating under three different lifts ranging from 65 to 165 feet. Because of heavy operation cost it is less profitable than the gravity systems.

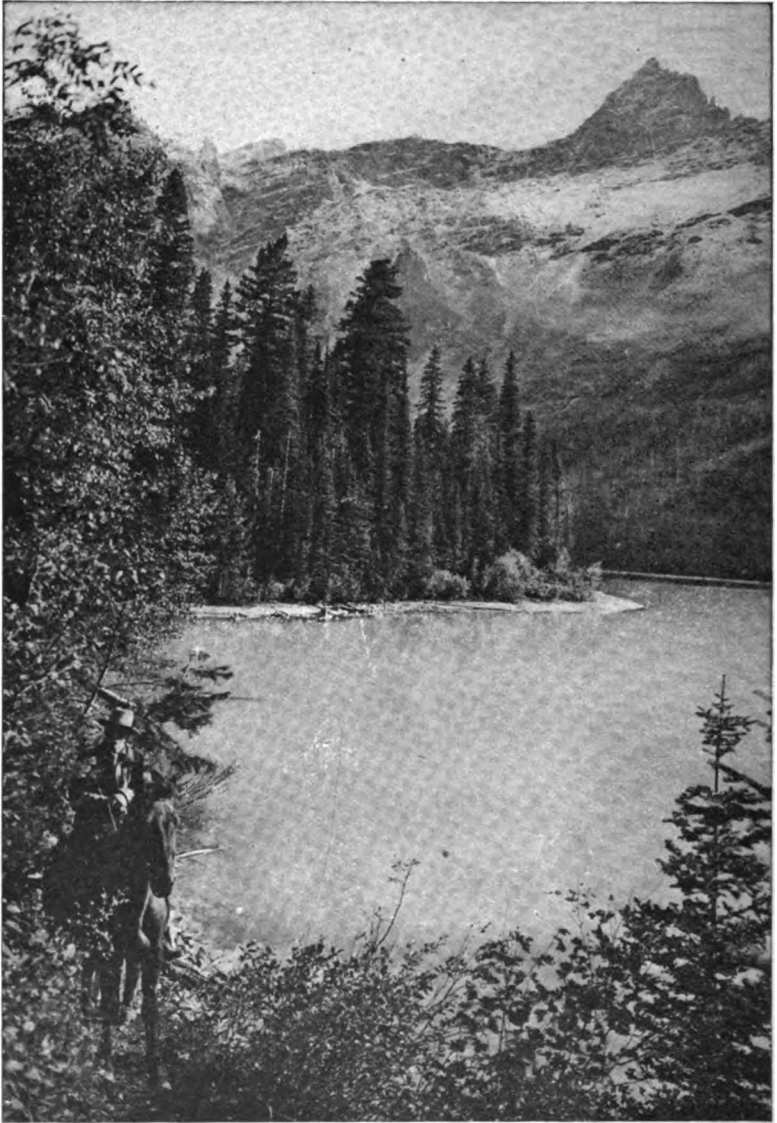
The Billings Carey Act Project and the Huntley U. S. Reclamation Project are described elsewhere in this report.

The Waco-Custer Irrigation District was created in August, 1920, to irrigate 4,500 acres along Yellowstone river in the east end of the county. Most of the lands have been irrigated under an old system for many years. A. M. Cooley of Custer is Secretary of the District.

The Danford Irrigation District was created in September, 1920, to irrigate 1,200 acres near Laurel, by diversion from Clark Fork river. About half of the lands are in this county and half in Carbon County. The lands have been mostly irrigated for 20 years under an old system and are very high priced lands.

The Victory Irrigation District was created in September, 1920, to irrigate 2,800 acres near Custer by diversion from the Big Horn river. They are preparing to issue \$52,000 in bonds to pay for construction.

It is possible to increase the present irrigated acreage, but at present drainage is more needed in this county than further irrigation, and the drainage problem is receiving principal attention.



Many Alpine Lakes Can Still Be Developed Into Good Reservoirs.



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